"UNIVAN" Alloy Cast Steel combines unusual strength with tough, shock-resisting properties. It is ideal steel for any casting in which resistance to fatigue is essential to economical performance. The alloys are scientifically blended to give best results, and every casting is given exact heat treatment to insure uniform structure and physical properties. One of the qualifications of "UNIVAN" is that it can be easily machined. "UNIVAN" Steel is Highly Recommended for:

- Rolling Mill Machinery
- Forging Machinery
- Riveting Machinery
- Bolt Heading Machinery
- Coupling Boxes, Spindles, Mill Pinions, Gears, Track Wheels, Knife Holders, Ladle Trunnions, Moving Parts of Flying Shears, Conveyor Links, Top Riders.
- Hammer Rams, Ram Guides, Sow Blocks, Die Holders, Forming Dies, Straightening Dies, Tool Holders, Gears.
- Riveter Frames and Riveter Arms.
- Header Dies, Pitmans, Pitman Caps, Toggle Links, Finger Levers, Header Holders, Slides and Yokes.

Specify Union Castings for that troublesome job.

UNION STEEL CASTING COMPANY, PITTSBURGH, PA.

"Build With Steel Castings"
Your
UPKEEP COSTS!
Help your “Bill Maintenance”
cut them down

Here are four definite advantages resulting from the use of Keystone Roll Neck Grease and the Keystone Pneuma-Lectric Lubricating System on Rolling Mill Equipment. This is not a matter of theory or conjecture, but of proven fact.

Wherever this system has been installed on Strip, Blooming, Plate, Rod or Bar Mills, in the steel, brass and copper industries, a positive improvement was immediately noted. At the very outset, mechanical efficiency was so stepped-up that in no time it was apparent that heretofore unheard of savings would be effected.

In every case, the passage of time has proved that the Keystone Pneuma-Lectric System is the greatest advance yet made in the lubrication of Rolling Mill Equipment. Not only does it actually save money—but through the rolling of a more uniform gauge, the product is improved.

Operation is completely automatic, yet is simplicity, itself.

Because of the long, fruitful experience of this company in the manufacture and application of lubricants, the Pneuma-Lectric System has back of it an unmatched heritage. This company’s reputation is proof that this system will accomplish in your mill what we say it will.

It will help you make a drastic saving in costs.

A Keystone Engineer, thoroughly trained in Rolling Mill lubrication, will be put at your disposal to discuss details at any time. Keystone Lubricating Company, 21st, Clearfield & Lippincott Streets, Philadelphia, Penna. Est. 1884.

See our exhibit at the National Association of Power Engineers, Kansas City Convention Hall, Kansas City, Mo., September 7th to 11th, 1931, spaces 57 and 58.

Note the compactness and extreme simplicity of the various units. The illustration to the right is a proportionately enlarged view of the rotary distributor. The lubricator unit above, including motor compressor set, may be placed in a convenient central location, while the timing clock is generally located in the operator’s control room.

© K. L. Co., 1931

KEYSTONE
Pneuma-Lectric
LUBRICATING SYSTEMS
Steel-mill Men Say:

“The G-E unbreakable resistor eliminates contact resistance—is practically noncorrodible—is worth the difference”

STEEL-MILL operators everywhere are enthusiastic about the G-E unbreakable resistor and here's why. They say: "The best resistor for our purpose is the one that has the absolute minimum of bolted connections. That's one good reason why we like the G-E unbreakable resistor—because its welded taps and terminals eliminate contact resistance for all time. For conditions of severe vibration there is no question that this resistor is worth the difference in cost over any other type. For our purpose, it's a 100-per-cent noncorrodible resistor, too, and we mount it any place in the plant. It stands up!"

The G-E unbreakable resistor *does* stand up—the severest kind of service in steel mills has proved its mettle time and time again. Its inherent features—rigid terminal supports, ready accessibility if changes are desired, availability for all possible resistor combinations—make it a consistent favorite.

Your operating department should have complete information on this heavy-duty resistor; ask your nearest G-E office for a copy of publication GEA-1295, giving complete details.

JOIN US IN THE GENERAL ELECTRIC PROGRAM, BROADCAST EVERY SATURDAY EVENING ON A NATION-WIDE N.B.C. NETWORK
ROLLING MILL EQUIPMENT
FOR
HOT OR COLD ROLLING

BLISS CLUSTER MILLS
ROLLER-BEARING EQUIPPED

These mills are built in capacities ranging from 4" to 72" wide for hot or cold rolling.

Full details on request.

E. W. BLISS CO., BROOKLYN, N. Y., U. S. A.

BLISS FOR MACHINERY
POSITIVE CONTROL

With Homestead Operating Valves

Your operator can have the same confidence—the same alertness due to freedom from laborious operations—as are had by this Manipulator operator in a large Ohio Steel Plant.

The positive control and ease of operation of Homestead Protected Seat Hydraulic Operating Valves are responsible for this operator's confidence that the products will be right in so far as accuracy of control can make it so.

In addition Homestead Operating Valves stop costly water losses, eliminate costly shutdowns, and give longer service with lower maintenance costs. Put them to work in your plant on the control of furnace doors, soaking pit covers, manipulators, presses, shears, hoists, lifts, sprays, etc.

HOMESTEAD VALVE MFG. COMPANY
P. O. Box 168
Coraopolis, Pa.
The OLD and The NEW

1906—MISCELLANEOUS ROLL LATHES

Belt Drives  Low Cutting Speeds
Countershafts  Chattering Difficulties
Open Gearing  Noise and Vibration
Babbitt Bushings  Light Construction
25 YEARS

of roll lathe development are well illustrated in these views of the roll shop of a prominent structural mill.

UNITED Roll Lathes as shown are now in operation on all sizes of rolls, for many kinds of mills.

1931—UNITED ROLL LATHES

Motor Drives  Good Cost Cards
Two speed Ranges  Clean Work
Enclosed Headstocks  Quiet Operation
Roller Bearings  Liberal Weight

UNITED ENGINEERING and FOUNDRY COMPANY
PITTSBURGH — PENNSYLVANIA

ROLLS AND ROLLING MILL EQUIPMENT
SAFETY, a watchword of the Steel Industry for many years, decreed the elimination of danger to the men on the blast furnace front, and the Brosius Automatic Clay Gun was developed. With its introduction all danger was removed from one of the most hazardous of steel plant operations; namely, the stopping of the tapping hole.

The tapping hole is plugged under full wind pressure, eliminating the chilling of the iron due to the usual check at the end of the cast, and resulting in increased iron production and a better operating furnace.

The illustration shows the Brosius Double Barrel Steam Operated Clay Gun, but for operators not desiring steam on the furnace front, we offer the Brosius Hydro Electric Clay Gun.

This gun is operated by a SINGLE 20 H.P. motor and a fluid pump located OUTSIDE of the cast house, away from danger of break-outs, etc.

The Brosius Steam Gun Equipment is so designed that if its users desire to dispense with steam on the furnace front the Brosius Hydro Electric Clay Gun can be substituted and used with the existing crane and clamping mechanism.

United States and Foreign Patents Allowed and Pending.

EDGAR E. BROSIIUS INC.
ENGINEERS and MANUFACTURERS
PITTSBURGH SHARPSBURG BRANCH PA.

More than 180 Blast Furnaces in the United States and abroad are equipped with Brosius Clay Guns.
THE SPECIAL ALLOY CASTING  "MAeHempIte"
FORGING  STRENGTH  TOOL STEEL WEAR

"MacHempIte" has been developed to meet the heavy duty demands of modern Rolling Mill Practice.

"MacHempIte", when applied to Mill Pinions and Gears, gives increased life and economical service.

We have extensive modern gear cutting facilities. We are able to cut all kinds, types and sizes of Gears, Pinions, Worms and Worm Wheels, and can duplicate any pitch, tooth form, or helical angle.

Your inquiries solicited

MACKINTOSH-HEMPHILL CO.
ESTABLISHED 1803 AT PITTSBURGH

General Offices:
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PITTSBURGH, PA.

Garrison Division
PITTSBURGH, PA.

Midland Division
MIDLAND, PA.

Wooster Division
WOOSTER, OHIO
Sheet and Tin Plate Producers can secure Lowest Ultimate Cost by adopting the Combination System.

**ROUGHING UNIT**
Continuous Pair Heating Furnace, Self Discharging.

**FINISHING UNIT**
Continuous Pack Heating Furnace, Self Discharging, Mechanical Feeder and Catcher.

Licensed under Patents and Patents Pending. The Combination of Continuous Furnaces and Mechanical Equipment for 2 High Mills and license to operate in this manner can be furnished only by The Wean Engineering Co., Inc.

The Wean Engineering Company, Inc.
Warren, Ohio

Flinn & Dreffin Co.
Associated Companies
The McKay Machine Co.
SPECIAL MILL MACHINERY
... with Co-ordinated Reduction drive

This Cold Strip Coiler, complete with stripping and unloading mechanism, was designed and built by Gears and Forgings, Inc. The G & F Worm Gear Drive installed on the Strip Coiler provides a smooth, even flow of power perfectly adapted to the requirements of the machine.

Proper co-ordination of mill machine and reduction drive means more efficient operation for both. We are fully equipped to design and build auxiliary mill machinery complete with co-ordinated reduction drive unit. Our experience with scores of steel mill installations, together with complete production facilities in our Ford City plant, formerly the Fawcus Machine Company, are available to you. Let our engineers work with you on your next job.

GEARS & FORGINGS, INC.
GENERAL OFFICES: 3014 WOODHILL ROAD, CLEVELAND, O., U.S.A.
District Offices: Chicago, Detroit, Buffalo, New York, Indianapolis, Pittsburgh... Factories: Cleveland, Chicago, Ford City, Pa.

GEARS AND INC. FORGINGS

MILL DRIVES - SPEED REDUCERS - CONTINUOUS STRIP TENSION COILERS - FURNACE DOOR OPERATING MECHANISMS
BILLET PUSHERS - PINION STANDS - SHEET LEVELERS - SPINDLES - MILL PINIONS - TUBE MILL EQUIPMENT
Without any "ifs or ands" — The Best Mill Motor Built

And Here's Further Proof

Type MD — the steel mill engineer's motor — has a shaft of high-grade steel — accurately machined. An armature spider, machined from heavy seamless steel tubing, is pressed on this shaft and keyed. The entire armature with commutator is assembled on this spider, and thus the shaft can readily be pressed out without any disturbance or injury to vital motor parts.

The armature core of the Type MD motor is formed from steel laminations keyed to the steel spider and rigidly clamped between two malleable-iron heads. The front head rests against a shoulder formed on the spider. The rear head is locked in place by a steel ring, which is shrunk into a recess in the spider while the core is clamped under pressure in a hydraulic press. Thus the core cannot loosen under any circumstances.

Roller bearings are used in all MD motors, and are completely enclosed in a frame head which is removable with the armature. Hence, the bearings are protected from dirt if the motor is disassembled on the job. The construction prevents lubricant getting on the motor commutator or windings.

Join us in the General Electric program, broadcast every Saturday evening on a nation-wide N.B.C. network.

GENERAL ELECTRIC
STANDARD-ALLOY
Heat Resisting Castings For Severe Mill Conditions

Walking beams that walk enable furnaces to run.

Built up to a standard 100% quality not down to a price.

Standardize on a standard product.

19,000 hours 1850° F.
Continuous service—capacity demanding conditions.

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EUROPEAN
Cesare Pavone
Via Settembrini, 26
Milan, Italy
Isley Furnace Control

Replaces: Reversing Valves and Stacks
Increases: Production, Furnace Life, and Regeneration
Reduces: Fuel Consumption, Repairs, and Costs

Unparalleled for Open Hearth, Soaking Pit, Forge, Reheating and all other Regenerative Furnaces

Using Fuel Oil, Tar, Natural Gas, Coke Oven Gas, Producer Gas, Blast Furnace Gas, and Mixed Gas.

Morgan Construction Co.
Worcester, Mass., U. S. A.
Wellman engineered and built the first machine for mechanically charging open-hearth furnaces — and has specialized on the development and construction of this class of equipment for over thirty-five years.

Every open hearth superintendent should send for this NEW 16-PAGE BULLETIN. It shows recent installations, and will give you a comprehensive idea of Wellman rugged construction, capacity, accessibility of parts and simplicity of design.
What has the PUSH-BENCH to offer

to the TUBE MAKERS of America?

... high-speed production of Seamless Tubes in the smaller Merchant Pipe sizes.

... utilization of low-cost steels.

... use of Square Billets. (which are forged into round, bottle shaped billets, by the Vertical Billet Press.)

... possibility of working ALL grades of steel, such as Bessemer, Open-Hearth and Alloy Steels.

... high-speed, multiple length production of Seamless Tubes in Butt-Weld Sizes. (by the addition of a Reducing Machine.)

... absolute uniformity of inside finish.

Our business is designing and building machines for rolling and finishing steel.

ROLLING MILLS  . . . Seamless Tube Mills, Blooming Mills, Billet, Bar and Rod Mills, 4-High Sheet Mills, Rail, Structural and Universal Mills, Tin and Sheet Mills.

FINISHING EQUIPMENT  . . . Cold Drawing Equipment, Straightening Machines, Pipe Cutting and Threading Machines, Galvanizing Equipment, Rolls, etc.
MISCO sectional valves may be used at temperatures up to 2000° F.

Reversing Valves
Stack Dampers
Waste Heat Valves

Do not require cooling—Do not scale—Do not warp

MICHIGAN STEEL CASTING COMPANY
1988 GUOIN STREET, DETROIT, MICHIGAN
FROM THE OPERATING STANDPOINT

A machine of precision for the finest finishing—but rugged enough to do the heaviest kind of roughing work. Crowning and concaving attachment an integral part of machine and guaranteed to produce any desired amount of crowning or concaving absolutely uniform and accurate.

Anti-friction bearings throughout. » » Belts, chains, gear-shifting eliminated.

MESTA MACHINE COMPANY
PITTSBURGH, PA., U. S. A.

ROLL GRINDERS
Freyn-Design Pressure Burner for Boilers—

OUTSTANDING FEATURES

1. Multiple gas and air ports provide intimate mixing of gas and air.

2. Gas and air ports are refractory lined, thereby presenting no metal surface to furnace temperatures.

3. May be mounted horizontally or vertically. Vertical mounting provides for cross firing from corners, leaving walls of combustion chamber clear for powdered fuel or other firing.

4. Arranged to be operated by any system of automatic combustion control.

5. Suitable for any gas temperature or pressure and for any air temperature or pressure.

6. Built to any desired capacity and to suit any furnace width.

A DESCRIPTIVE BULLETIN WILL BE SENT AT YOUR REQUEST
325 Installations of Electric Roll Heaters—prove superiority of electrical method for preheating sheet and tin mill rolls

Practically all of the large manufacturers of high grade sheets use Freyn-Design Electric Roll Heaters. That satisfactory results are secured is apparent from the large number of repeat orders for this equipment.

Freyn-Design Electric Roll Heaters may be equipped with an Automatic Heat Regulator for maintaining constant heat on rolls placed in midweek preheating racks, thereby assuring rolls at proper temperature throughout the week.

INVESTIGATE—Why Freyn-Design Electric Roll Heaters have outsold every other form of roll preheating. Why three-fourths of Freyn-Design Electric Roll Heaters are purchased on repeat orders. How Freyn-Design Electric Roll Heaters cut operating costs in sheet and tin mills.

{THE FREYN-DESIGN ROLL HEATER BOOKLET ANSWERS THESE QUESTIONS. LET US SEND IT TO YOU}

Freyn Engineering Company
CONSTRUCTORS - ENGINEERS - SPECIALTIES
310 SOUTH MICHIGAN AVENUE - CHICAGO U.S.A.

ASSOCIATED WITH:
ASHMORE, PENSON, PEASE & CO., LTD., STOCKTON-ON-TEES, ENGLAND.
SECOMET, 64 RUE LA BOETIE, PARIS, FRANCE.
STEEL PLANT BUCKETS BUILT BY BLAW-KNOX ARE DESIGNED BY SPECIALISTS HAVING INTIMATE EXPERIENCE WITH CONDITIONS GOVERNING THEIR USE. THESE BUCKETS ARE SUCCESSFULLY SERVING AMERICA'S LEADING STEEL MAKERS IN HANDLING OPEN HEARTH SLAG, LIMESTONE, LUMP ORES, SKULLCRACKER PIT CINDERS, BLAST FURNACE SLAG, ROLL SCALE, ETC.

Ask our nearest office for copy of catalogue 1234 which fully describes and illustrates Steel Plant Buckets.
CASTINGS
OF DISTINCTION AND HIGHEST QUALITY
(SHOWN IN THE ABOVE PHOTOGRAPH)

are not made by chance. Fortunate it is that a place among "the few" is attained only through the sincerest effort and most intelligent work and may not be attained otherwise.

Pride of ownership and pride of craftsmanship are akin to each other. The castings shown above are accurate in form and design to meet a fixed problem and perform a definite service.

The same type of engineering and metallurgical study to your problems will doubtless produce economical results. This can be done without cost to you. Our organization is at your disposal.

MICHIANA PRODUCTS CORPORATION
MICHIGAN CITY INDIANA
Absolute Control of Final-Carbon Content through the use of SILICO-MANGANESE

The proportions of silicon and manganese in Electromet Silico-Manganese are such that it may be added to acid steel to advantage. The low-carbon content of this alloy simplifies the making of low-carbon manganese steels and offers an excellent means of absolute control of final carbon content.

Electromet Ferro-Alloys are the result of more than 20 years of study and research in high temperature metallurgy. They are electric furnace products manufactured under the most careful technical control to assure uniform analysis, freedom from objectionable impurities, physical cleanliness, and correct sizing. It will pay you to investigate their advantages.

Sole Distributors
ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide and Carbon Corporation
Carbide and Carbon Building, 50 East 42nd Street
New York, N.Y.

CHROMIUM
High-Carbon Ferrochrome (maximum 6% carbon)
Low-Carbon Ferrochrome (in grades, maximum 0.06% to maximum 2.00% carbon)
Chromium Metal
Chromium-Copper
E. M. Chrome Briquets
Miscellaneous Chromium Alloys

MANGANESE
Standard Ferromanganese
78 to 82%
Low-Carbon Ferromanganese
Medium-Carbon Ferromanganese
Manganese Metal
Silico-Manganese
Manganese-Copper
Silico-Spiegel
E. M. Manganese Briquets
Miscellaneous Manganese Alloys

SILICON
Ferrosilicon 15%
Ferrosilicon 50%
Ferrosilicon 75%
Ferrosilicon 80 to 85%
Ferrosilicon 90 to 95%
Refined Silicon (minimum 97% Silicon)
Calcium-Silicon
Calcium-Aluminum-Silicon
Calcium-Manganese-Silicon

TUNGSTEN
All Grades

VANADIUM

ZIRCONIUM
Aluminum-Zirconium
Silicon-Zirconium
Zirconium-Ferrosilicon

Electromet Ferro-Alloys & Metals
1700° F. in the Furnace—
Yet the room is cold!

General view of the heat treating room in a large automobile parts factory. Armstrong's Insulating Brick are used to confine the heat to the furnaces.

Visitors to the plant of a prominent manufacturer of automobile parts wonder at the comparative coolness of the heat treating rooms. They are still more amazed to learn that a separate heating system is needed to keep sprinkler pipes from freezing in winter! This in spite of temperatures as high as 1700° F. in the furnaces.

There are several furnaces in the heat treating room—furnaces for carburizing and hardening large and small parts. Each unit is insulated with Armstrong's Insulating Brick. Walls are covered with a 9-inch layer, arches with 9 inches, and bottoms with 7 1/2 inches. With this efficient insulation, the room is cold despite the high furnace temperatures.

Fuel consumption is less and working conditions are improved when high temperature furnaces are insulated with Armstrong's or Nonpareil Insulating Brick. The latter is used for temperatures up to 1600° F., Armstrong's to 2500° F., both behind the refractory. There are further savings in the fact that both these brick are machine-sized for ease and accuracy in laying up. See them and test them for yourself—we will gladly send you samples on request. Address Armstrong Cork & Insulation Company, 941 Concord Street, Lancaster, Pennsylvania; Canadian offices in Montreal, Toronto, and Winnipeg.

Armstrong's and Nonpareil Insulating Brick
RAYMOND IMPACT MILL DESIGN

Assures a common sense balance of Efficiency, Capacity, and Maintenance

In the design of Raymond Impact Mills no effort has been spared to provide a high speed pulverizing unit that operates on a common sense balance of efficiency, capacity and maintenance.

These mills operate with a higher degree of reliability and sustained fineness of pulverization throughout the entire life of the equipment than any other high speed mill on the market.

Power consumption is at a minimum commensurate with proper provision for air drying in the mill and for maintaining sustained fineness to assure efficient operation regardless of wear.

Proper materials and accessibility to wearing parts, insuring rapid replacement when necessary, place the Raymond Impact Mill among those high speed pulverizing units operating with lowest maintenance costs.

The high percentage of repeat orders received from users evidences the satisfactory results secured from mills already installed.

COMBUSTION ENGINEERING CORPORATION
200 Madison Avenue
New York, N. Y.
DIFFUSION COMBUSTION
SUCCESSFULLY APPLIED TO WALKING-BEAM SHEET PACK FURNACES

This SC walking beam pack furnace... with SC Diffusion Combustion system of firing... is installed in a large mid-western sheet mill... capacity 12,000 lbs. of packs per hour... high pressure natural gas utilized as fuel.

STEEL mill men have never been entirely satisfied with clear flame combustion in heating sheets for rolling... Surface Combustion worked untiringly on the problem and evolved the answer... Diffusion Combustion. This process imparts luminosity to a gas flame and produces a "smoky" atmosphere. A combination of clear flame burners and diffusion burners gives just the right atmosphere condition to produce soft rolling steel with a non-oxidized surface. Surface Combustion pioneers the application of Diffusion Combustion to pack furnaces with this successful installation in a large mid-western mill. Consult Surface Combustion engineers on your furnace problems.

Surface Combustion
SURFACE COMBUSTION CORPORATION
TOLEDO, OHIO.

OPERATED BY HENRY L. DOHERTY & COMPANY

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES
Linde Oxygen

Plants and warehouses in all industrial centers make Linde Oxygen, in the familiar grey and green cylinders, available everywhere at minimum transportation cost. Users also benefit from the unique engineering facilities of Linde Process Service.

Pres-O-Lite Acetylene

Pres-O-Lite Dissolved Acetylene . . . the standard for well over a quarter of a century . . . is available from a Pres-O-Lite plant or warehouse near you. Pres-O-Lite is portable, convenient, economical.

Oxweld Apparatus and Supplies

Suitable Oxweld blowpipes, regulators, welding rods and supplies are available for every operation. Complete stocks and service stations are located in all principal cities. Oxweld low-pressure injector type blowpipes, High Test welding rods and other supplies represent maximum values in oxy-acetylene welding and cutting equipment.

Union Carbide

Careful expansion of distributing facilities has made Union Carbide available to every American industry from over 250 warehouse stocks. Sold always in the Blue and Grey drum, it has been the accepted standard for uniform high quality for more than 30 years.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants 627 Warehouse Stocks

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

Blast Furnace & Steel Plant

This broken pipe mold flask was slated for the melting pot—

but oxy-acetylene welding restored it for a long period of use.

Foundry attributes $72,000 annual saving to Oxwelding!

The value of oxwelding for reclamation of damaged equipment recently was given additional emphasis when a large foundry credited an annual saving of $72,000 to the use of the oxy-acetylene process.

Every working day this foundry had scrapped four damaged two flasks worth from $60 to $80 apiece. By using oxwelding to restore these flasks to service, they effected this splendid saving.

Similar surprising economies are possible in every industry. Used for maintenance and repair, oxwelding will save thousands of dollars in replacement charges—and, in emergencies, when replacement parts are not at hand, it will prevent expensive shutdowns and delays.

THE LINDE AIR PRODUCTS COMPANY

District Offices

Atlanta Detroit New York
Baltimore Pittsburgh Philadelphia
Boston St. Louis
Buffalo San Francisco
Chicago Indianapolis Seattle
Cleveland Kansas City Minneapolis
Cleveland Los Angeles Milwaukee
Denver Salt Lake City San Francisco
Denver St. Louis San Francisco
Denver Seattle Seattle
Denver New Orleans

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO
“NATIONAL”

ROLL

ROLLING MILL MACHINERY

ROLLS

Plain Chilled Rolls—Special Chilled Rolls
Cold Rolls—Sand Rolls

Extra Hard Rolls for Brass—Copper—Aluminum

The National Roll & Foundry Company
Office and Works: AVONMORE, PA., U.S.A.
A gear wheel in steel mill service is often subjected to shocks that render it useless long before it should have been discarded in the course of normal wear. Often it is a new gear wheel that is damaged.

Thermit welding quickly, easily and efficiently repairs such damage. It is not necessary to run chances of wrecking your equipment by running with a broken gear. Neither is it necessary to wait for the foundry and machine shop to get out a replacement.

Perhaps you have a number of gear wheels, or other parts, that have been sent out to the “bone yard.” Obey the modern demand for economy. Repair this discarded equipment and get it back into service.

A reclamation department in which Thermit plays an important part is an essential in the modern steel plant.
weather

The uncontrolled variable affecting every combustion or process operation. Variations in humidity (moisture in the air) are often responsible for irregularities in results, which seem unexplainable where humidity conditions are not recorded.

Are you checking this variable?

By supplying exact information in the form of 24-hour ink-records of humidity conditions, Bristol's Psychrometers are proving valuable around Blast Furnaces, Storage Rooms for Steel and Tin Plate, Drying Rooms, Experimental Laboratories, Etc., Etc. Illustrated in a self-contained model.

Also available in distance type (Recorder may be mounted 100 ft. or more from control point.)

Typical Chart with records of wet and dry bulb temperatures made with Bristol's Recording Psychrometer on a drying room installation. For complete data, write or phone your nearest Bristol Branch Office.

BRISTOL'S Instruments for Indicating—Recording—Controlling.

The Bristol Company · Waterbury, Conn.
THE DE LAVAL WORM REDUCTION GEAR is simple in itself, a worm and worm wheel giving any speed ratio up to 100 to 1, and it also simplifies the arrangement of the driving and driven machinery and of the plant as a whole. Further, it simplifies upkeep, an occasional inspection of oil level being the only attention required.
DUST and ELECTRICITY Won't Mix

Reading Railway Bars Dust From Its New Wayne Junction Frequency Converter Station

As the first step in the electrification of its system, the Reading Railway Company has established at Wayne Junction, near Philadelphia, a frequency converter station for its Chestnut Hill Branch. And, as an essential step in insuring the protection and maximum efficiency of this station, American Air Filters have been installed.

When dust deposits on the windings of electrical machinery local overheating and short circuits occur. The results are depreciation, costly repairs and, often, shut-downs.

The two buildings of the Wayne Junction frequency station are equipped with four automatic air filters that clean 216,000 cubic feet of air every minute. This forced ventilation of dust-free air cools the electrical apparatus, prevents collection of dust particles in air passages and on coils, and permits maximum operating efficiency.

American Air Filters are being installed by leading steel mills and others users of electrical machinery. As results, motor capacity is increased, cost and upkeep are reduced, shut-downs due to cleaning and rewinding are eliminated. American Air Filters are made by the world’s largest manufacturers of air-cleaning equipment. Without obligation, write for information that will show you the actual savings American Air Filters have effected; that will show you how American Air Filters will increase your operating power and decrease your operating risks and costs. American Air Filter Co., Incorporated, General Offices, 109 Central Ave., Louisville, Ky., Factories, Louisville, Ky., and Bradford, Pa.
The McCann-Harrison Corporation is the ONLY company that can offer the recognized advantages of the Walking Beam Conveyor combined with forced and controlled circulation of heating gases within the heating chamber and around the work.
Mantle Recuperators are of unit construction...smaller sizes consist of a single self-contained unit which is shipped to the user ready to set in place. Larger sizes consist of two or more units which are assembled at the factory before shipment to assure minimum of erection labor in the field. The recuperator sets entirely above the ground, eliminating costly excavation.

The Mantle Recuperator is built in a number of standard sizes and designs to meet the wide variations in plant and furnace arrangement.

Write now for the new Mantle Recuperator Catalog and Bulletin...it contains the latest data on metallic recuperation.
GREATER COMPACTNESS IN ADJUSTABLE SPEED REDUCTION

Announcing Westinghouse-Wise multi-speed drives...

FEATURES

1. Provides complete four-speed drive in one unit.
2. Easily installed in small space.
3. Permits changing speed instantly under full load with motor running.
4. Wide selection of different motor speeds and gear ratios for each size.
5. High overall efficiency.
6. Ball bearings throughout.
7. Accurately generated, heat-treated gearing assures quiet operation and long life.
8. All moving parts automatically lubricated.

UNPRECEDENTED simplicity, compactness, and high efficiency in obtaining adjustable speed operation with constant speed a-c. motors, are introduced in the new Westinghouse-Wise multi-speed drives.

Changing speeds with these new drives is even easier than shifting gears in an automobile. A small gear unit, built on the bracket of a Westinghouse type CS motor, permits four different changes in driving speed. A change from one speed to another can be made instantly under full load without stopping the motor. And the motor need not be stopped when it is desired to stop the driven equipment, for neutral points are provided in the speed-changing mechanism. There's no clashing of gears as they are always in mesh.

Installation is greatly simplified as the motor feet support the entire drive. Hardly more space is required than for a motor alone.

Simple in design, but sturdy built throughout to a high standard of precision, these multi-speed drives operate at a high overall efficiency and require no adjustments. Maintenance amounts to no more than occasional lubrication.

This newest Westinghouse-Nuttall product is built in three sizes, including twenty different motor ratings ranging from 1/2 horsepower at 900 rpm. to 7 1/2 horsepower at 1800 rpm. Any four of several hundred different speed combinations can be supplied in each size with a maximum ratio of about 3.5 to 1.

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July, 1931
Blast Furnace & Steel Plant
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Volume XIX    JULY, 1931    Number 7

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When Koppers plants supplement or partially replace existing equipment, they bring new vigor to the entire coke and gas producing structure. Whether the addition consists of Becker Ovens, By-product apparatus, or a material handling plant, its relation to the customer's equipment and business is carefully worked out in terms of current operating and sales practice.

The result is a unified, revitalized plant that makes new records in production and efficiency.

Our engineers will be glad to help you consider the application of Koppers plants to your coke and gas requirements.

THE KOPPERS CONSTRUCTION COMPANY
KOPPERS BUILDING
PITTSBURGH, PA.
An Oversight

WITH no intention at all to detract from the credit due our steel companies for achieving prodigious records of production, we should not fail to give just consideration to the means by which these records have been made possible. Perhaps, we are inclined to place too great a value on the human aspect of an achievement and not enough on the mechanical. Likewise, we are apt to lose sight of the fact that in the creation of the machinery employed to make a record there is also a human element. Engineers are required to conceive and to build a machine as well as are engineers required to operate it. This is not only true of machines, but of all the equipment that is required by our steel mills.

Today there appear to be two rather distinct trends toward progress in the production of steel. One trend is within the steel plant, the other without. The former is the increased attention being paid by steel plant officials to improvements in the quality of their products. This is illustrated by the vast amount of research now being conducted. The second trend originates with the manufacturers of machinery and other equipment. It is evidenced in the improvement in the design and in the quality of equipment of various sorts. Illustrations of this improvement are: the increased productive capacity of the modern rolling mill, of blast and open-hearth furnaces, the longer life of furnace linings, etc.

Where records have been established, have we not been too meager in our allotment of credit to the machine itself?
What!

... a straightener with wrinkles...?

Yes, wrinkles... new wrinkles that tend to elevate a machine of age-old theory above that of the average. You've seen, if you are—or have been a man of the mill, many a straightening machine in action... possibly they've been plate levelers, however, their principle of operation bear close resemblance... you've heard the clink and clatter of their drives (spindles and boxes) at running speed... you've noticed the absence of endwise roller adjustments, and, possibly an interior oiling system... yet these incorrect methods continue to function in many an otherwise modern setting.

Birdsboro markets its new straightener for angles and miscellaneous stock, into which design has been incorporated an improved universal joint on all drive spindles—insuring absolute silence; a special (patented) endwise adjustment of rollers; an automatic oiling system—pumping to all bearings—and other features to be made known thru correspondence.

BIRDSBORO STEEL FOUNDRY AND MACHINE COMPANY
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BIRDSBORO, PENNSYLVANIA
IMPORTANCE of CYANIDES in IRON SMELTING

By WM. McCONNACHIE

In connection with this matter, it is very generally taken that the elaborate and careful tests made by Kinney & Guernsey, as recorded in Technical Paper No. 390 of the U. S. A. Bureau of Mines, prove conclusively that the cyanides are of no great importance in iron making, and that, while they may be formed in considerable quantity, they do no serious amount of work as they are destroyed by the blast.

The observers however point out that their tests show a very different distribution of the cyanides from that obtained by earlier experimenters, notably by Bell, and, since it cannot be supposed that one blast furnace differs in the manner of cyanide formation and distribution very seriously from another, we are free to suppose that some mysterious cause has been at work to occasion such very marked difference in the results as obtained, and that the various data on record only require correlation and proper interpretation to make them agree in substance.

As may be seen from reference to Table 12 (Tech. Paper No. 390) there was found below tuyere level on one occasion cyanide = to 558 oz. KCN per 1000 cu. ft. of gas.

The furnace was, one may suppose, in normal working order, except that one of the tuyeres, that above the slag notch, was shut off, which we may interpret as showing that the rate of driving was less by 8.5 per cent. A second test, at the same point, with the same prevailing conditions, gave only about 1/10 of the cyanide, the only difference recorded being that the furnace was running with 5 lb. gas pressure instead of the normal 15 lb. or so.

Since the effect of a temporary reduction in the rate of driving must be that the more easily fused substances constituting the primary slags will run ahead of the lime, it follows that there would be a greater amount of alkaline silicates and less lime present to decompose them, so with temporary slower driving there would be less alkaline oxides distilled from the slag, and consequently less cyanides formed.

The same reasoning applies to the lessened rate of driving caused by the closing of one of the tuyeres, so that we may reasonably take it that the amount of cyanide recorded as found, large as it is, is still short of the actual quantity produced by the furnace, below tuyere level, when in full operation.

The fact noted by the observers that some alkalies
had condensed out of the gases, and so some may have been projected out with the small quantity of gas of the sample, may be interpreted as proving that that part of the furnace was not hot enough to keep the alkaline substances in the state of gas, and the gas of the sample traversing such a cooler space would lose some of the contained cyanide. We may thus take the recorded figures as substantially correct, and not unduly high.

Cyanides found in such quantity below the tuyere level prove conclusively that they must have been formed there; it is utterly unthinkable that, if formed above tuyere level, they could descend without being volatilized by the rising current of gases at such high temperatures. As any gas formed in the well must rise, and cannot rise through a horizontal stream of blast, it will be compelled to rise next the wall, or in the center of the furnace, so we find such gases mainly in the quiet sectors next the wall, and between tuyeres, as can be shown very conclusively by reference to Van Vloten’s charts showing sampling points in his most instructive investigations on “Combustion in the Blast Furnace Hearth” (Stahl und Eisen, 1893).

By shutting off the tuyere above the slag notch, the sector was enlarged and left free from the disturbing influence of the blast, so that the gas obtained was similar to that which would be obtained at a point next the wall between two tuyeres, and is shown to have carried large quantities of cyanides exactly as it is on record was found by various other observers. The cyanides being taken off at a lower level, are accompanied by less ordinary furnace gases than in cases recorded by Bunsen & Playfair, Bell, etc., and consequently show a greater amount of cyanide per 1000 cu. ft. of gas.

**Reason for Small Amount of Cyanide**

Keeping the mechanical principles involved in mind, we can easily understand why in the first place so very little cyanide was obtained in the other tests of gas from the slag notch, and further, why so comparatively little was found in the gas drawn off 27 in. above tuyere level. The sampling hole was as nearly vertical over a tuyere as could be managed, and in such a case no great amount of cyanide could be expected, as the stream of gas carrying cyanides, as gas, would be rising between the tuyeres.

We can see from the foregoing that cyanides are formed in considerable quantity, and, since it cannot be supposed that any large portion can ever come into contact with the raw blast, and further, since the quantity found at higher levels is comparatively small, we must believe that the cyanides have been decomposed in doing work useful to the furnace.

The heat absorbed in their formation in the “well” is restored to the furnace at a point where it is useful, and, as at the temperature of the spaces where the final removal of the oxygen of the ore must be effected, they exist as true vapor, we must consider them of the utmost value, as they represent the reducing power of solid carbon transmuted into most energetic gaseous form, and so capable of reaching and acting on a large surface of unreacted or partly reduced ore.

In the data as to the cyanides found below tuyere level, we seem to have the best clue to the rate at which they are formed, which of course is of the utmost importance in estimating the value of the cyanides in furnace work.

Since we know that a considerable amount of oxygen is carried down in solid form into the well in metallic oxides, which are there reduced to metal by carbon, or at the expense of carbon, the oxygen leaving the well as CO produced therein, and further, since the cyanides are formed partly from the nitrogen of the furnace gases, it follows that the minimum quantity of gas formed in the well containing cyanides, as shown by Kinney & Guernsey, can be obtained as a reasonable approximation, from which we may infer their potential value as to the work of reduction in the furnace.

From Van Vloten’s little known but highly instructive work on “Combustion in the Blast Furnace Hearth” (S. und E., 1893) we learn that in the stream of gases from one tuyere, on taking samples a little above the point where active combustion ceases (as shown by the absence of free oxygen), that there is a shortage of combined oxygen, amounting to 14 per cent, as shown by the ratio of

$$\frac{N_2}{O_2}$$

which, instead of 265 vol. oxygen per 1000 vol. nitrogen, only shows 224 vol. oxygen per 1000 of nitrogen.

That this oxygen which has been rendered non-gaseous does not go out of the furnace as fume, or in the silica of the slag may be considered proved, for we find an extra ratio of oxygen to nitrogen in the gas when sampled where any gas formed in the space between the liquids in the “well” and the tuyere level, must appear—that is in the quiet part of a sector between any two tuyeres, and towards the center of the furnace, beyond the point where the blast stream loses its horizontal direction, and therefore does not oppose the ascent of gas formed underneath. Making some allowance for the fact that all the gas produced by the action of the blast on carbon cannot be in the main stream where sampled (since those formed by the under edge of the horizontal ingoing blast must take a different path), and for a further small quantity of oxygen which will go out in the silica of the slag, we may reasonably assume that ½ in. of the oxygen supplied in the blast is carried down into the “well” in the form of reducible metallic oxides, which, on being reduced—by carbon, or if not, certainly at the expense of carbon—generate CO gas, which must rise in the quiet sectors, where it will always be found indicated by the increased ratio of oxygen to nitrogen.
The furnace from which Van Vloten's figures were obtained took 930 kilos of coke (of an ash content of 9.5 to 10 per cent) per 1000 kilos Thomas iron, which is equal to 2030 lb. of carbon per ton of basic pig iron.

Assume that of this quantity 1500 lb. carbon are oxidized, directly or otherwise, by the oxygen of the blast (the remainder being available for direct reduction, decomposition of CO\(_2\) from the flux and ore, formation of cyanides, and carburization of the iron), then 1500 lb. carbon take

\[
\frac{1500 \times 16}{12} = 2000 \text{ lb. oxygen},
\]

and as \(\frac{3}{8}\) in. of the oxygen of the blast is carried down (in non-gaseous form) into the well, this gives us 250 lb. of oxygen which takes up carbon =

\[
\frac{250 \times 12}{16} = 187.5 \text{ lb.}
\]

The sum of those 250 + 187.5 = 437.5 lb., gives us the weight of CO gas formed in the well, and is = to 7000 oz., which is equal to

\[
\frac{7000}{1.26} = 5555 \text{ cu. ft.}
\]

With a cyanide content of 558 oz. per 1000 cu. ft. the CO gas formed on the production of the alkali metal of the cyanide, together with the oxygen associated with the nitrogen absorbed, amounts to 135 cu. ft. or so.

The 1000 cu. ft. of gas carrying 558 oz. KCN may be taken as made up of 135 ft. of gas produced when that amount of KCN is formed plus 865 cu. ft. of CO produced in the well on the ultimate reduction of the reoxidized metal.

Then as 5555 cu. ft. of CO are so produced per ton of pig iron we have

\[
\frac{5555}{865} = 6420 \text{ cu. ft.}
\]

as the total gas volume produced in the well. If the gas sample taken at the slag notch (when the adjacent tuyere was shut off, and the blast was at full pressure) consisted wholly of gas generated below tuyere level (which is highly improbable) this would give us

\[
\frac{558 \times 1000}{6420} = 223 \text{ lb.},
\]

approximately 2 cwt. of cyanide (taken as KCN) per ton of pig iron.

The gas formed in the well must, however, have been mixed with some gas produced on combustion by the blast, as the nitrogen of the cyanide could only be obtained from such. Since there is no analysis available, we have again to rely on Van Vloten's data for approximation.

As a point about midway between two tuyeres, but near the wall, at tuyere level, the ratio of the gas was such as to show 421 vol. O\(_2\) present per 1000 vol. nitrogen.

The total volume of such gas per 1000 vol. N\(_2\) may be arrived at thus: Of the 421 vol. O\(_2\) (combined) found with 1000 vol. of N\(_2\), 265 vol. = 530 vol. CO have entered the blast and the remainder, 156 vol. = 312 vol. CO, have come from the "well."

The total vol. 1000 + 530 + 312 = 1842 vol., of which 312 vol. or approximately one-sixth have come from the well.

While we cannot assume that the sample taken through the slag notch would contain such a proportion of the gas as produced below tuyere center level by the blast, we may be sure that there was considerably more than an equal quantity of gas from this source, mixed with the gas originally produced in the well and carrying the cyanides.

If we assume that the gas from the well was mixed with 1.5 times its volume of gas from combustion, then the cyanide (taken as KCN) produced per ton of iron made = 5 cwt. instead of the 2 cwt. found as above (which should be regarded as the absolute minimum). The quantity of cyanides, viz., 558 oz. per 1000 cu. ft., seems much higher than any other on record, but may really be too low.

Bell relates having found cyanogen (experiment 604, "Chemical Phenomena of Iron Smelting") equal to 111 grams per cu. m. which is equal to 277 oz. of KCN per 1000 cu. ft. (This was taken about 1 ft. above tuyere level and must have been closely adjacent to a tuyere.) From the analysis of gas given as obtained at that point there must have been a very large proportion of gases from the combustion mixed with the cyanide carrying gases originating in the well.

The composition of the gas as given, viz. (by Weight), CO, 3.26 per cent, CO\(_2\) 35.37 per cent, N\(_2\) 61.37 per cent, also shows that the gas could not have been sampled directly over a tuyere as would be naturally taken from Bell's description. Gas taken at such a point would show a shortage of oxygen as demonstrated by S. P. Kinney and his colleagues, and by the earlier work of Van Vloten, whereas the analysis given shows a

\[
\frac{N_2}{O_2}
\]


A probable explanation is that when Bell, as he describes, "had a hole drilled about a foot above one of the tuyeres of the Wear furnace" it was found impossible to drill the hole in a truly radial direction. The "ballhead" of the connection between the horseshoe main and the tuyeres would be directly in the way, and as this connection in the older furnace construction might be only 2 ft. distant from the bosh wall, the angle at which a hole could only be drilled would be very considerable, and so the
end of the hole inside the furnace would be very considerably away from a perpendicular rising from tuyere center. It may be noted that furnaces in Cleveland (Yorkshire) had sometimes walls 54 in. thick at this part, even at a later date than that of Bell's experiments. As the tuyeres were not likely to be over 4 in. diameter, we can see how the gas sampled very probably consisted of rising gas originating in the well mixed with a large quantity of gas from combustion by the blast, and as there was no thought of any serious quantity of gas originating below tuyere level, the exact position of the hole inside, even if noted, would be considered of no consequence in connection with his immediate purpose, which was the estimation of the carbonates formed at that part of the furnace.

We may thus interpret the exceptionally high results obtained at low levels in the furnace by Bell and by Kinney & Guernsey as being in substantial agreement.

The latter's figures prove conclusively, as had been deduced from the older data (Blast Furnace and Steel Plant, Sept. 1930) that the cyanides are formed below tuyere level, and, bearing this in mind, and also giving due weight to the mechanical principles involved, all the data concerning the distribution of cyanides can be put into proper perspective. The highest result obtained below tuyere level may be too low, as already explained, but, by taking the oxygen carried down into the well by the reoxidized crude iron, plus that given up by the alkali metals on cyanide being formed, as a measuring unit, we see that cyanides equal at least to 2 cwt. of KCN (and in the opinion of the writer more than twice as much) were being formed when the tests were made, for each ton of pig iron produced.

Reliable data from the really important points of the furnace are very scarce but now we have it proved where the cyanides are chiefly formed, and how they can rise in the furnace without being destroyed by the blast, and further, now that we have a unit with which we can measure their quantity, it may be hoped that some progressive ironmaster, or association of such, will have the matter definitely proved by making a few practical tests. A very few would suffice, if intelligently directed, and carefully carried out.

It should be remembered that the chief controlling factor in the production of cyanide in the blast furnace is not the amount of alkali in the charges, but rather the amount of free, or easily got at, silica, since we cannot hope to have large quantities of alkali returned to below tuyere level if we do not provide a sufficiency of silica or the like to combine with and so insure their return.

As each pound of KCN on oxidation to K₂O and CO will require .369 lb. oxygen and so could reduce 1.295 lb. of iron from FeO, it will be evident that this minimum quantity of 2 cwt. KCN per ton of pig cannot be looked upon as trifling. While indicated above, there is substantial reason to suppose that the real amount is much larger, making this matter of the cyanide of all the greater importance.

---

**Blast Furnace Group Holds Spring Meeting**

The Eastern States Blast Furnace and Coke Oven Association held its annual spring meeting and election of officers for the coming year June 5 at the Wildwood Country Club, Wildwood, Pa. The morning program consisted of separate meetings of the blast furnace and coke oven groups, at which gatherings subjects pertaining to blast furnace and coke oven operations were discussed. The afternoon was spent in golf, and a banquet that evening concluded the meeting.

Howard P. Zeller, Jamison Coal & Coke Company, Greensburg, Pa., was elected president of the association for the coming year, succeeding J. E. Lose, general superintendent, Homestead steel works, Carnegie Steel Company, Pittsburgh. Other officers elected were: Vice president, J. T. Whiting, Hamilton Coke & Iron Company, Hamilton, Ohio; secretary-treasurer, H. M. Crossett, superintendent of coke ovens, Cambria plant, Bethlehem Steel Company, Johnstown, Pa.

---

**Action of Sulphur Dioxide on Manganese Oxides**

SULPHUR dioxide may be the means of future utilization of the large deposits of low-grade domestic manganese ores, according to the United States Bureau of Mines, Department of Commerce. Three progress reports on a study of the hydro-metallurgy of manganese, bearing on different phases of the problem, have been prepared by the Bureau’s Rare and Precious Metals Experiment Station, Reno Nev., in co-operation with the University of Nevada.

One of these progress reports involves the dissolution of manganese from ores. Sulphur dioxide gas, a waste product at many smelters, passing counter current to pulp flow in a specially designed leaching drum, readily dissolves the manganese from the principal oxides and also from the carbonates after calcination.

Another report records a study of the oxidation of hydrated oxides of manganese, the object being the production of maximum percentage of the dioxide of manganese.

A third report deals with sulphur dioxide and manganese oxides at elevated temperatures. There is now in course of preparation an article on the recovery of manganese from its solution for metallurgical uses.

OIL CIRCULATING SYSTEMS for the STEEL MILL

By L. W. KOHLER
Manager, Lubrication and Filtration Division, S. F. Bowser & Company

LUBRICATION in the steel mill perhaps presents a greater problem than in any other industry. Massiveness of machinery, abnormal heat and cold, high speed and pressure, and enormous power consumption all tend to make this subject of vital importance to the maintenance and production engineers of the steel industry.

To prevent costly shut-downs and to increase production, efficient lubrication is necessary, and realizing this designers of rolling mill and steel mill machinery, with the co-operation of mill operators and lubrication engineers, have gone into the subject of lubrication and through this have increased the efficiency of machinery.

Lubrication in the older design of rolling mills was provided for by at least two kinds of lubricant, one a tar like compound which was used on the teeth of the drives and pinions, and either oil or grease was used for the bearings. This necessitated costly construction as provision had to be made to prevent two lubricants from mixing, and where an improper level of oil was carried either excessive heat was generated or the level was too low to permit the dipping of the teeth causing inefficient lubrication. Where grease was used on the bearings frequent adjustment of grease cups was required, and where oil was used either the oil found its way into the gear case, diluting the gear compound or the compound would get into the bearings clogging the oil grooves and causing excessive friction.

Experiments were conducted to determine whether or not it would be possible to use one kind of lubricant for the bearings and teeth of these mills and have proved so successful that this form of lubrication incorporating continuous circulation of one kind of oil or grease to all points of lubrication has been adopted and practically all mills installed within the last seven or eight years have been so equipped. The oil companies have developed oils and greases to suit all kinds of conditions and are in a position to furnish one oil or grease for the lubrication of bearings and gear teeth, resulting in much more efficient operation, reduction in wear and operating cost, elimination of frequent shutdowns on account of faulty lubrication, and increased production.

Oil Circulating Systems

Like the evolution of the design of the mill for efficient lubrication, through the co-operation of all those interested, has been the design of oil circulat-

Fig. 1—Diagram of full filtration system
Fig. 2—Application of oil to reduction gears

Fig. 1 shows what is termed a full filtration system where all the oil in circulation is filtered each cycle. This system employs two sets of twin pumps; one set being a service unit and the other a spare. One unit of the pump forces the oil from the receiving tank to the filter and after passing through the filter units to the clean oil compartments the oil is pumped by the other side of the twin unit through the pressure tank to the points of lubrication.

The pressure tank operates pneumatically and is equipped with three pressure switches so that when the oil reaches a predetermined pressure, the pump is automatically cut out until a minimum predetermined pressure is reached when it is again cut in; the variation in pressure is only a few pounds. Should the service pump fail to cut in, a second switch starts it, and should this fail a third switch sounds an alarm.

In selecting a proper oil for use in a circulating system of this type, consideration must be given to the pressures to be encountered and an oil with a viscosity and film strength to withstand these pressures must be used. The oil should have as high a demulsibility and as low a cold test as is possible, for considerable moisture is ever present in the steel mill, and in the northern climates very low temperatures may be encountered; thus an oil with a low cold test that will flow freely at low temperatures is essential.

A typical arrangement of the major apparatus making up a complete oil circulating and filtering system is shown in Fig. 1. Used oil from the bearings, gear cases and pinion housings flows by gravity to the receiving tank located at a point sufficiently below the lowest outlet to permit a drop in the drain piping to allow for free flow and prevent the building up of oil levels in the housings or bearings.

On entering the receiving tank the oil comes in contact with a heating coil installed therein to decrease the viscosity of the oil, permitting it to more readily precipitate the heavier particles of foreign matter and water; the water being automatically ejected from the receiving compartment by means of a water ejector, the oil then passing through screen baskets to a second compartment which is equipped with a floating suction, so that only surface oil is drawn off at all times.
Partial filtration systems are also employed where a part of the oil in circulation is filtered on each cycle. With this system the oil after passing through the filter returns by gravity to a point adjacent to the floating suction in the receiving tank so that the cleanest oil is always being discharged through the feed lines.

Pressure systems are generally used where high viscosity oils are circulated, and in these systems a pressure filter is incorporated; the discharge from the pumps to the pressure tanks passing through the filter. These systems are also designed for either full or partial filtration of the oil in circulation.

Fig. 2 illustrates the means of application of the lubricant to reduction gears wherein the oil is applied by means of sprays directly at the point of mesh of the teeth, the location of the sprays depending on the direction of rotation. In some instances in addition to the sprays a level is maintained in the case so that the teeth dip, while in others no level is maintained, the oil flowing out through a drain in the bottom of the case.

The accepted method of applying the oil to a reversing pinion set is through a manifold above the top pinion, and baffle plates are installed on the inside of the housing, the rotation of the pinion throwing the oil onto the baffle plates, which in turn direct the oil into the meshing point of the teeth. Where the pinions are not reversing oil sprays are installed and the baffles are not required.

Each feed line leading into the case is equipped with a sight flow indicator and a control valve, and the quantity of oil being fed is visible and controllable at all times. Fig. 3 shows the application of the feed and drain pipe on a plain bearing and Fig. 4 on a ring or collar bearing.

The number of points of application on each bearing depends on the length of the bearing and the bearing pressures, and each point of application is equipped with a sight feed oiler that is adjustable and is vented to prevent the fogging of the glass.

The glass is of sufficient diameter to provide for visibility at considerable distance.

In the collar oiled bearing an overflow fitting is installed to maintain a constant level in the bearing and the outlet is piped to the bottom so that accumulation of foreign particles are continuously washed out.

The circulating oiling system maintains a constant pressure of lubricant at all the points of lubrication regardless of surrounding temperature and assures of a copious stream of clean cool lubricant being applied at all times. The cost of lubrication per ton of steel rolled is reduced to a very minimum; actual records showing that in systems circulating approximately 150 gal. per min. of oil, the consumption is less than one barrel per week.

Where steel of the proper carbon content is used in the manufacture of gears and pinions, and the proper lubricant is used and applied by circulating systems, these units will last indefinitely; observations showing that after many months of operation gear teeth still showed tool marks and the contour of the teeth was perfect.

When properly designed, installed and filled with the proper lubricant for the work to be done, the central system solves the problem of lubrication in the steel industry.

Rich Deposit of Iron Ore Found

An important discovery of a rich deposit of iron ore has been reported in the Steep Rock Lake area near Atikokan, Ontario, on the Canadian National Railways west of Fort William. The ore is a hematite and is reported to be of the best quality. The new discovery is not to be confused with the Atikokan Rim range which is a high sulphur magnetite.

An analysis of the ore shows that it contains 65 per cent iron and 23 per cent silicon with .03 per cent phosphorus. The analysis shows no trace of sulphur.
HAIR CRACKS on the SURFACE of SHEETS

By ERICH A. MATEJKA

Dipl. Engr., Witkowitz

This work was undertaken in order to aid in solving one of the many unexplained questions on the production of good sheets, and to aid in the production of perfect boiler materials satisfying the most rigid requirements in particular. The work represents an attempt to find ways and means of recognizing a surface defect in sheets, the cause of which could not be determined satisfactorily up to this time.

The necessary investigations were made in the steel and rolling mill plant of the Witkowitzer Bergbau und Eisenhütten-Gewerkschaft.

Meerbach1 says, in regard to the defects to be studied, “Finally, one type of surface crack must be mentioned, which covers large parts of the sheet like a network and encloses regions from 25 to 30 mm. in diameter. The formation of these cracks, which apparently appear only under fixed conditions, has not yet been absolutely established. As they have been observed principally during the cold season, it might be reasoned that a cracking of the highly heated surface takes place as a result of the quenching action of the outside air, or cold water.”

A further characteristic of the defect shown in Fig. 1 is the shallowness and fineness of the cracks which frequently can hardly be seen with the naked eye and frequently only become visible when a test piece breaks in a tensile testing machine (Fig. 2). It is remarkable that these surface cracks appear neither in entire heats nor in certain ingots. Good and bad sheets are frequently rolled from one ingot. Thicker sheets tend to crack more than thin ones, and generally only one side of the sheet is defective. A further observation is the frequent appearance of the cracks at red scale spots on the otherwise blue sheet surface, which leads us to expect some effect of the rolling temperature on the formation of the defect.

Finally, one more circumstance should be mentioned which makes it somewhat more difficult to answer the question as to whether the defect to be studied is a defect in material or in working. As was already mentioned, this work was done in the new steel works of the Witkowitzer Bergbau und Eisenhütten-Gewerkschaft, which produces most of the sheet steel used by the rolling mill; in addition, ingots for sheets (called sheet ingots) are also supplied by a second steel works, the cast steel plant.

The sheets made from the material here did not have as great a tendency to form surface cracks as those from ingots from the new steel works. At first this observation caused us to think that the appearance of surface cracks was due to a defect in the material.

Before starting the report on the experiments we wish to give a short description of the usual method of producing the material for sheets.

There are eight basic furnaces in the new steel works—four Talbot furnaces with a capacity of 200 tons, one 80-ton tilting Wellman furnace and three 60-ton stationary open-hearth furnaces. The heats intended for the production of sheets were cast on three cars with plates for the bottom-cast sheet ingots and three cars for the top-cast ingots. As can be seen from Fig. 3, before the ingot proper, three molds (I) are cast, then on three cars are 12 molds (X) for the sheet ingots (sometimes (III) for thinner or narrower sheets). The other two cars and molds (III) are arranged to take the rest of the heat.

In Fig. 3 the Roman numerals indicate the kind of mold, and the Arabic numerals under the molds show the sequence in which the sheet ingots are cast.

The more important dimensions of these molds are:

Mold I—Inside width on top 470 x 470 mm.; inside width on bottom 530 x 530; wall 110 mm. thick and 1900 mm. high.

Mold III—Inside width at top 525 x 525 mm.; inside width on the bottom 610 x 610 mm.; wall 120 mm. thick and 2000 mm. high.
strict supervision was maintained on the quality of the material during manufacture. It was found in this that some ingots showed slight superficial cracks even on the preliminary rolling; frequently the sheets rolled from them showed surface cracks. In contrast with this, it was observed in other cases that blooms with surface cracks gave good sheets. These observations need only be mentioned here as a characteristic of the defect; their explanation will be discussed later on.

**Purpose and Execution of the Preliminary Experiment**

The preliminary experiments were intended to explain, as far as possible, whether in this case it is a defect in material or in the method of working. For this purpose nothing was changed during the preliminary experiments on the production of the material in the steel works, but only individual characteristic influences during the production of the steel were singled out and investigated as to their relation to the defect. Furthermore, using the results of the preliminary experiments, the most suitable order in which to make the main experiments could be established.

As a measure of the quality of a heat in the preliminary experiments, there was selected several blooms free from surface defects after rolling. This number was expressed as a percentage of the total number of ingots used for the manufacture of sheet from the heat in question. The ingot was not followed to the finishing rolls, but only to the blooming mill. As the preliminary experiments were used only for a tentative explanation, this was done, as already stated, because many ingots showed surface cracks on rolling to blooms, and there seemed to be no relation between these cracks and those on the finished sheet.

The following influences were tested during the production process in the 134 heats of the preliminary experiments for their relation to the appearance of surface cracks on rolling the ingots to blooms, using the Daewes method of large scale research:

(a) The type of steel melting furnace,

(b) The different kinds of pig iron,

(c) The manganese content of the heat before tapping,

(d) The use of roll scale on finishing,

(e) Finishing with ore,

(f) The use of coke for carburization in the ladle,

(g) The strength of the material,

(h) The length of time for making the heat,
with a low manganese content or with a too short melting time.

The result of the preliminary experiment was important in so far as it showed that the appearance of surface cracks on sheets is influenced only to a limited extent by certain circumstances during the production of the steel. But as some of these influences have a certain connection with the defect, it became necessary to develop the main test on the broadest basis in order to discover whether each of the many influences in the production of the steel are of importance in the formation of the defect.

Main Experiment to Determine the Cause of the Defect

The supervision of the operations was so worked out that each individual ingot from heats that were to be used for the production of sheets could be followed from tapping to the completion of rolling and to testing in the materials testing department. The measure of the quality of a heat was no longer the behavior of the ingots on blooming, but the yield of sheets with good surfaces was used. The surface quality of the bloom or tensile test-piece was determined accurately. The main experiment consisted of single tests and of large scale tests according to the Daubes system of large scale research. These tests included 379 heats, that is, about 4500 ingots or about 10,000 sheets. Altogether, 34 processes or materials used in the production of sheets were studied for their connection with the defect. By sifting the results obtained in this manner there could be determined the process in sheet production in which the defect starts. Thus the limits of the field of investigation were constantly made narrower.

The execution of the experiment followed the manufacture of the sheets. There were studied:

I—The making of the steel
II—The tapping of the steel
III—Heating the ingots and blooms
IV—Rolling
V—Behavior of material from the two steel works
VI—Metallographic investigation of the defect
VII—Determination of oxygen in the steel.

References


(To be continued)
WHEN in a wilderness where nature has located an abundance of rich iron ore, limestone and other materials, but where there is no available coking coal nearer than 1500 miles, a steel plant is to be planned for and built, the study involves not only every detail of steel plant design and operation but also the reconstruction and method of increasing operations on main line trunk railroads and connecting lines over great mileages, the mining and conditioning of large tonnages of iron ore, the quarrying and crushing of limestone and dolomite and all the accessory operations connected with the manufacture of steel.

Considering Asiatic Russia with coal mines in the Kuznez basin and extensive ore deposits in the south foothills of the Urals separated by a railroad haul of 1500 miles, the question has been raised regarding the wisdom of hauling the coal to the vicinity of the ore as is planned in connection with the major metallurgical project, for it is urged that we in the U.S.A. haul the ore to the vicinity of the coal mines. If that is economical for us, why is it not the best plan for them?

But in our case we have the advantage of the lowest of rates on the Great Lakes waterways and our plants are located mostly rather near to coal mines because that is also generally near the major markets for the finished steel products.

In the case of Asiatic Russia the capacity arranged for the eastern metallurgical works must be accommodated to the demand of that region for the steel made, and that leaves the larger portion of the projected capacity to be planned for the Ural region from which the demand of the neighboring regions and of a large part of the European regions must be satisfied.

The amount of ore that it is contemplated to take from the Magnitnaya region will yield 5½ million tons of concentrate yearly and of this something over a million tons will be shipped eastward; the remainder, it is planned, will be reduced at the metallurgical works at that point. The coal required for this works will amount to 3½ million tons yearly and so the actual tonnage of coal is less than that of the ore; however, the bulk of the coal is greater, requiring more cars in transit. The product of this works will probably reach 2½ million tons per year, and as it will be necessary to ship this product in small capacity cars these shipments will become twice as burdensome to the Russian railroads as an equal tonnage would be to railroads in the U.S.A. From these considerations it becomes easy to conclude that the proportionate sizes of these two works should be set to accommodate the respective regional demands for steel.

Thus there will likely be a shipment of ore eastward of not over 1½ million tons and a shipment of coal westward of 3½ million tons yearly. In order to accomplish these movements, along with other regular traffic, there will be from 26 to 30 trains per day moving each way over the Trans-Siberian railway and the connecting branches, and to accommodate this movement these railway lines must be completely double tracked and modernized. This construction program has been attempted with the help and advice of many American railway experts, and these railways will be brought up to American standards eventually. Even though the best of railway facilities were available, there is no parallel to this contemplated haul of coal and ore over such a distance, 1500 miles entirely by rail, in any operation in this country, our long hauls being accomplished over the Great Lakes waterways without which (and their cheap rates) the progress of the iron and steel industry in America would have been very materially retarded. This great distance from the plant of one essential major material in each case places the Russian steel program under a serious handicap, and one that may prove a restriction to the industry in the long run.

In this interplant haul something like 15,000 cars will be required, passing westward loaded with coal and returning eastward some loaded with ore and some with steel products or other loads for intermediate points, and unless freight routing is carefully planned many of these cars will return empty. The Trans-Siberian railroad will become of prime importance in the industrial life of all Russia and failure in its efficient functioning even temporarily will be a serious matter to the general industrial situation, due to its tie-up with these new large metallurgical plants.

Ore and Mining at Magnitnaya

The location and depth of the ore deposits in this region have been carefully studied only since 1926. These ore deposits lie on the slopes of the hills, and principally of Atach which will be the site of the
major mining operations in the near future. Ore has been mined from Eshofka, and is being mined in minor quantities from Dalmia. The others of the five hills of this region are granite.

All the ore deposits are lenticular in form, being quite thick at the central portion and carrying very little overburden. At the upper portions the deposits are broken up by the natural weathering process and are interspersed with clay, and the weathering has leached out most of the sulphur. These softened upper portions are known as the scattered ores and from them a considerable amount of very pure ore of the composition of hematite may be obtained by hand picking. These ores are to be treated by washing to remove clay, and the fines will be recovered by concentration and sintering.

Just below these softer strata are the massive and rock-like formations grading from the soft ores and of a similar composition (Fe₂O₃) and known as the intermediate ores. These are only partly weathered, although of low sulphur content, and will have to be blasted before they can be dug.

Below the depth of the perceptible weathering and where the sulphur content becomes high, these massive strata take on the aspect of the original formations and are called the primary ores. This is the magnetite (or Fe₃O₄) and is the most massive part of the formation and must also be fragmented by blasting before digging.

The concentration process on the intermediate ores does not necessarily include any special attempt to eliminate sulphur, but incidentally sulphur is reduced by the process of magnetic separation. As the ores must be crushed to preferred sizes (1½ in.) in the separation of the rock a proportion of fines results and this, if saved, must be subject to fine grinding and wet separation and finally to sintering in order to be delivered to the blast furnaces in a proper condition for charging.

The principal objects in the treatment of the primary ores are the separation of sulphur bearing pyrites and of excess rock waste. These ores are therefore subject to fine grinding and wet magnetic separation, with the subsequent necessary sintering.

Mining will be arranged on a schedule that permits of delivering the various classes of finished ores in the following proportions:

<table>
<thead>
<tr>
<th>Finished Ores</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washed scattered ores</td>
<td>24.37</td>
</tr>
<tr>
<td>Washed and sintered scattered ores</td>
<td>1.68</td>
</tr>
<tr>
<td>Dry magnetic treated interm. ores</td>
<td>26.68</td>
</tr>
<tr>
<td>Sintered primary and Interm. ores</td>
<td>47.27</td>
</tr>
</tbody>
</table>

The primary and intermediate ores are to be mined throughout the year, but the scattered ore cannot be dug after the ground freezes. Thus a certain amount of the mining equipment will be idle part of the year.

The mining operations will be in the nature of open pit mining except that they will differ from the Lake Superior mining in the amount of blasting necessary due to the hard nature of the formations. The overburden will be scraped into windrows from which it can be shovel loaded into dump cars for disposal. The two yard electric shovels provided for the scattered ore will be used for loading the overburden.

The entire thickness of the layer of scattered ore will be taken out in one bench by means of two yard electric shovels of the caterpillar type. The only blasting contemplated is the blockholing of boulders to reduce them to loading sizes.

All massive ores will be taken out in 10-meter benches after fragmentation by blasting by means of electric shovels of the caterpillar type of 4 cu. yd. capacity. This operation can be conducted throughout the entire year. While the methods of mining are the same for both the primary and intermediate ores the two classes will be kept separate in shipment.

For the blasting, holes at proper spacing will be dug with churn drills electrically driven and moving upon caterpillar tractor gear. The vertical holes so drilled will be carried 36 ft. deep in order to extend below bench floor level. The spacing will have to be determined by experimentation in order to produce the proper fragmentation. The size of hole found best for the purpose is one with area of 51 sq. in. When toe holes are found to be necessary they will be spaced between the vertical holes and drilled with 55-lb. jackhammers to a depth the same as the verticals. Blockholing will be done on large masses with 40-lb. jackhammers to reduce them to loading sizes, Dynamite will be employed for the charges and the vertical holes loaded to halfway up with 30 lb. per lin. ft., differential loading being practiced to protect weak strata. The extensive operations contemplated will consume 500 lb. steel for churn drills per day and 170 lb. steel for jackhammer drills per day. Dynamite will be required at the rate of 4800 lb. per day. The amount of ore with the accompanying rock waste taken out in full operation is contemplated at about ten million tons per year.

The method pursued in mining the massive ores will be as follows: Each shovel will work at its location or bench, moving on its own power, and will load trains of five cars each on side track, each train being constantly served by its regular locomotive, and hauled to and from the unloading location. This seems to provide the most economical distribution of motive power, as otherwise time is lost by the shovel and blasting equipment.

The mine locomotives will be powered electrically with 600 volt d.c. from overhead collector system. These locomotives are rated at 60 tons, and there will be 27 of them in active service during seasons of full operation. The caterpillar shovels will be powered with 3000 volts a.c., 3 phase, and the churn drills with 380 volts, 3 phase a.c. The estimated power consumption of the mining and railway operations is 19½ million kw.h. per year.

A dispatching system will be arranged to take care of the proper movement of trains over all parts of the mine railroad. This system will be operated
from a central point, and is a very necessary part of the transportation system due to the congested traffic at the switchbacks in the hillsides.

The cars to be provided for hauling ore and rock waste are special side dumping cars of 60 tons, 30 cu. yd. capacity, 125 of these cars being in active service at one time.

In mining, it will be the object of the schedules to mine 2,500,000 tons per year of scattered ores and 7,500,000 tons of the massive ores. From this 10,000,000 tons of ore mined there is expected to be a yield of 5,500,000 tons of concentrated ores.

The washing of the scattered ores may be described in detail as enough has been determined about the nature of these ores to be sure of the required treatment. The ores as mined are delivered to bins from which they are fed by a pan feeder to a 10-in. grizzly and washed with water from lines at 60 lb. pressure. Oversize from this grizzly goes to a jaw crusher, still washed by the water, and when crushed is mixed with the undersize and passes by gravity to a 6-in. grizzly, being continually washed with water. The undersize from this grizzly falls upon a vibrating screen separating ½ in. and over. This is delivered to Dorr washers, and undersize with all wash water is pumped to the bowl classifier. Oversize from the 6-in. grizzly is transferred onto a picking belt where the clean ore lumps are hand picked as well as clear rock waste lumps, each classification going to its respective bin on conveyors. The mixed lumps of combined ore and rock are led to a Symons crusher and vibrating screen. Oversize is conveyed to the ore bins and the undersize to the bowl classifier.

The Dorr washer delivers: (1) oversize from trommel to go to Symons crusher, (2) rake product which is finished concentrate, (3) overflow which goes to the bowl classifiers. From the bowl classifiers there are two products: (1) a rake product, fine, going to the sintering plant, and (2) slime with fine ore in suspension going to a settling pond.

The above description indicates the extent of the washing operation, and it is estimated that for the washing plant there will be pumped 12 million gallons of fresh water and 22½ million gallons of recirculated water per day. Including the washing plant and the wet and dry magnetic plants with crushers, etc., it is estimated that the consumption of electric power will be 91 million kw.h. per year for ore concentration.

The estimated cost of ore and limestone delivered to the blast furnaces is as follows:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washed scattered ore</td>
<td>$0.637</td>
</tr>
<tr>
<td>Sintered from scattered ore</td>
<td>1.487</td>
</tr>
<tr>
<td>Dry magnetic concentrate</td>
<td>0.8425</td>
</tr>
<tr>
<td>Wet concentrate sintered</td>
<td>2.2425</td>
</tr>
<tr>
<td>Average for all classes of ore</td>
<td>$1.465</td>
</tr>
<tr>
<td>Limestone</td>
<td>$0.717</td>
</tr>
</tbody>
</table>

### Table 1—Blast Furnace Burden Sheet—Bessemer Iron

<table>
<thead>
<tr>
<th>Materials</th>
<th>Wt.</th>
<th>% SiO₂</th>
<th>% Al₂O₃</th>
<th>% CaO</th>
<th>% MgO</th>
<th>% Fe</th>
<th>% P</th>
<th>% Mn</th>
<th>% S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore No. 1</td>
<td>5170</td>
<td>4.88</td>
<td>252</td>
<td>83</td>
<td>43</td>
<td>1.14</td>
<td>59</td>
<td>.29</td>
<td>15</td>
</tr>
<tr>
<td>Ore No. 2</td>
<td>356</td>
<td>5.34</td>
<td>19</td>
<td>91</td>
<td>3</td>
<td>1.25</td>
<td>4</td>
<td>.32</td>
<td>1</td>
</tr>
<tr>
<td>Ore No. 3</td>
<td>5660</td>
<td>6.13</td>
<td>347</td>
<td>1.62</td>
<td>92</td>
<td>2.93</td>
<td>166</td>
<td>.61</td>
<td>34</td>
</tr>
<tr>
<td>Ore No. 4</td>
<td>10080</td>
<td>4.92</td>
<td>495</td>
<td>1.67</td>
<td>168</td>
<td>1.68</td>
<td>168</td>
<td>.99</td>
<td>99</td>
</tr>
<tr>
<td>Ore Totals</td>
<td>21216</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bessemer slag</td>
<td>630</td>
<td>57.51</td>
<td>362</td>
<td>1.43</td>
<td>9</td>
<td>1.34</td>
<td>8</td>
<td>.32</td>
<td>2</td>
</tr>
<tr>
<td>Roll scale</td>
<td>630</td>
<td>55.93</td>
<td>55</td>
<td>1.37</td>
<td>1</td>
<td>1.32</td>
<td>2</td>
<td>.11</td>
<td>1</td>
</tr>
<tr>
<td>Acid added</td>
<td>1100</td>
<td>75.00</td>
<td>825</td>
<td>25.00</td>
<td>175</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Totals</td>
<td>23576</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>Limestone</td>
<td>4875</td>
<td>1.57</td>
<td>77</td>
<td>.57</td>
<td>28</td>
<td>33.4</td>
<td>203</td>
<td>.82</td>
<td>40</td>
</tr>
<tr>
<td>Limestone factor</td>
<td>1.92</td>
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<tr>
<td>SiO₂</td>
<td>2788</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>850</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>SiO₂</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>CaO and MgO</td>
<td>-602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiO₂ to slag</td>
<td>138.25</td>
<td>130000</td>
<td>.0033</td>
<td>4.58</td>
<td>134.17</td>
<td>13000</td>
<td>.945</td>
<td>1300</td>
<td>.945</td>
</tr>
</tbody>
</table>

### Notes on Table 1
- **Bessemer slag**:
  - Washed scattered ore: $0.637
  - Sintered from scattered ore: 1.487
  - Dry magnetic concentrate: 0.8425
  - Wet concentrate sintered: 2.2425
  - Average for all classes of ore: $1.465

- **Limestone**:
  - $0.717
Ore No. 3
Ore No. 2
Ore No. 1

Mn.—ore
O. H. Slag

Ore No. 4

978

Assun

SiO₂
AL₂O₃
SiO₂

Limes
Coke

Limestone factor at Magnitogorsk from the mines in the Kuznezk basin is stated to be $7.93 per ton. The average cost of mining the scattered ores is estimated at $0.1886 per ton, and of mining the massive ores at $0.30625 per ton.

Coal and Coke

The cost of coking coal delivered to the metallurgical plant at Magnitogorsk from the mines in the Kuznezk basin is stated to be $7.93 per ton. On this basis it has been estimated that coke delivered to the blast furnace stock bins will cost about $12.87 per ton, and this cost was calculated taking into account all credits allowed for gas and by-products. The most modern methods will be followed in the operation of the Koppers ovens, and blast furnace gas will be used as fuel, thus releasing all the coke oven gas for the important high B.t.u. fuel requirements of the project.

With this high cost of metallurgical coke, which is due in large part to the long railway haul, it will hardly be possible for Russian plants to compete with the plants of other lands in adjacent markets. The fact that the ore comes to the furnaces continuously from the concentration plants obviates the necessity for elaborate equipment in order to deliver ore to the stock bins from storage and leaves room for the delivery of coke direct from the ovens to the bins by conveyors. Thus the coke ovens are laid out adjacent and parallel to the stock bins.

Table II—Blast Furnace Burden Sheet—Basic Iron

| Materials | Wt. | SiO₂ | Wt. | AL₂O₃ | Wt. | CaO | Wt. | MgO | Wt. | Fe | Wt. | P | Wt. | % | Mn | Wt. | % | S | Wt. |
|-----------|-----|------|-----|-------|-----|-----|-----|-----|-----|----|-----|---|-----|----|-----|---|----|-----|
| Ore No. 1 | 5334 | 4.88 | 260 | 33 | 44 | 1.14 | 61 | .29 | 15 | 58.15 | 301 | .0173 | .9227 | .052 | 2.77 | .20 | 10.686 |
| Ore No. 2 | 898 | 5.34 | 29 | 91 | 3 | 1.25 | 5 | .32 | 1 | 63.67 | 324 | .009 | .0699 | .056 | 3.97 | .20 | 11.676 |
| Ore No. 3 | 5839 | 6.13 | 358 | 1.62 | 94 | 2.98 | 171 | .61 | 36 | 61.52 | 359 | .0082 | 1.1626 | .086 | 8.90 | .20 | 10.694 |
| Ore No. 4 | 10347 | 4.92 | 509 | 1.67 | 173 | 1.68 | 174 | .99 | 102 | 63.44 | 654 | .018 | 1.8624 | .086 | 8.90 | .20 | 10.694 |
| 21868 | 286 | 147 | 314 | 411 | 154 | 13491 | 3.9176 | 15.84 | 43.776 |
| Mn.—ore | 285 | 10.55 | 30 | 1.45 | 4 | 2.50 | 7 | 1.68 | 5 | 2.00 | 6 | .25 | .7125 | 47.86 | 136.40 | .32 | .912 |
| Acids add. | 924 | 693 | 231 | 2780 | 209 | 13886 | 24.6903 | 213.36 | 48.464 |
| 25457 | 2293 | 616 | 1308 | 346 | 23886 | 373.37 | 48.464 |
| Assuming | 5% loss | 24184 | 2178 | 858 | 1243 | 329 | 13192 | 23.4558 | 354.70 | 46.04 |
| Coke | 12000 | 4.60 | 552 | 2.40 | 288 | .45 | 54 | .14 | 17 | .89 | 96 | .045 | 3.4000 | .80 | 96.00 |
| Totals | 36184 | 2730 | 873 | 1297 | 346 | 13288 | 28.8585 | 354.70 | 142.04 |
| Limestone | 3174 | 1.57 | 50 | .57 | 18 | 53.40 | 1695 | .82 | 26 | .008 | .2539 | .05 | 1.58 |
| 40358 | 2780 | 891 | 2992 | 372 | 13288 | 29.11 | 354.70 | 143.62 |

Limestone factor 1.92

Calcium oxide factor 1.92

1000 tons metal 6.488
Coke ton per lb. 1850
Slag ton per lb. 1070
Limestone ton per lb. 499

S in pig, per cent... 2.00
S in pig, per cent... 0.33

P in iron, per cent... 0.203
Mn in iron, per cent... 1.86
S in slag, per cent... 2.00

Ores to the Blast Furnaces

It is estimated that the washed ore will contain about 58 per cent Fe, .017 per cent P and .176 per cent S. The sintered washed ore will therefore contain about 63.67 per cent Fe, .018 per cent Phos, and .20 per cent Sul. These calculations assume 10 per cent moisture for the washed ore and 2 per cent for the sintered ore.

The products of the concentration of primary and intermediate strata constitute two final compositions. The average mixture of the upper and lower portions of the intermediate strata is calculated to yield 63.44 per cent Fe, .0182 per cent Phos and .20 per cent Sul. The primary strata it is calculated will yield upon concentration 61.52 per cent Fe, .0172 per cent Phos and .20 per cent Sul.

These calculations were based upon the analyses made on many drill holes by the Russian engineers, geologists and chemists in their investigations of the deposits, taking into consideration the fact that the determinations represent cleaner ore than will
be delivered in mining. Certain later determinations seem to indicate that the phosphorus content, of certain portions of the deposits at least, runs higher than at first shown, and for this reason and on account of the high percentage of phosphorus shown by the coke, the plan for the Bessemer production has been deferred until more definite information is gathered.

The following burdens were made up tentatively to determine costs and other data in connection with blast furnace practice. In making up these sheets certain figures were used for the content of acid materials in the concentrates and a sufficient amount of gravel is shown as added to make up the deficiency. It is likely that in the practice of concentration the acids left in the ore will partially if not wholly make up this deficiency. Table I shows the calculation for the burden in making Bessemer iron, and Table II the calculation for the burden in making basic iron. No attempt is here shown to keep the low phosphorus deposits separate for making Bessemer iron.

In these burden sheets it will be seen that the manganese is obtained so far as possible from additions of the steel making slags. However, in the basic burden a certain amount of manganese ore is required in addition to the basic open hearth slag that can be added. The amount of the slags that are added to the burden also influence the limestone requirement, and the limey content of the concentrates may be found to vary, but in any event the burden is arranged to carry a little over 1000 lb. of slag per ton of pig iron, enough to keep the sulphur content of the slag down to 2 per cent. Coke per ton is shown, as assumed, in the burden sheets. The calculated Bessemer iron indicates a Phos. of .0686 per cent, which is of course amply low for very excellent practice. The basic iron is estimated to contain .203 per cent Phos., and is planned for about 1.8 per cent Mang.

(To be continued)

Continuous Copper Rod Mill

THE United Engineering & Foundry Company, maker of rolls and rolling mill equipment, in response to demands from manufacturers of copper rods, has designed and built a new continuous type of copper rod mill which has capacity for the production of between 50,000 and 60,000 lb. of ¼-in. round rods per hour with low operating cost.

At the same time, the mill is so designed that it will operate profitably on a small production basis, showing better costs than the old type Belgian copper rod mill, which produces from 25,000 to 28,000 lb. of rods per hour.

The company has also designed a low production mill, operating on a capacity of 10,000 to 15,000 lb. per hour, also at a lower cost of production than the old type Belgian mill. Heretofore, the older type of Belgian mills could not be operated profitably on less than 15,000 lb. per hour because the labor cost exceeds the limits of profitable operation.

The new continuous type of mill does not entirely eliminate labor, but reduces it to a minimum, as the mill is equipped with automatic repeaters, coilers, etc.

Lubrication Meeting at Penn State

THE Penn State meeting, the first ever held by the Society which was solely devoted to the subject of lubrication, proved unusually successful. It was held on May 22 at Pennsylvania State College under the joint auspices of the Lubrication Engineering Committee of the Petroleum Division of the Society and the College, with sessions in the beautiful new Nittany Lion Inn located on the college campus.

Registration exceeded expectations, for 125 were present at the technical sessions. Among those in attendance were men of prominence in the lubrication-engineering field, including representative groups from oil companies, bearing manufacturers, machinery manufacturers, etc.

Survey to Cover Progress of Lubrication

On Thursday evening preceding the meeting, the Lubrication Engineering Committee met. Dr. P. H. Conradson, who developed the carbon residue test, was a special guest upon this occasion. W. F. Parish, chairman of the committee, announced plans for future activities, including the making of an historical survey to cover the progress of lubrication of various types of machinery and engines during the last 30 years. The object of this survey is to bring out forcibly the fundamentals in the application of lubricants and the changes in engine and machine design which make successful lubrication possible. Dr. Conradson spoke from his wealth of experience in lubrication and promised his support in the work. It was also announced that the Committee would sponsor a session on steel-mill lubrication at the coming annual meeting.

The first session of the meeting opened on Friday morning with Dean R. L. Sackett presiding. The first paper, on "Lubricant Testing," was presented by O. L. Maag, of the Timken Roller Bearing Company. This was followed by Prof. L. J. Bradford's paper on "Bearing Design in the Light of Oil-Film Pressure Investigations." The third paper on the program, by F. O. Wilhofft, dealt with the "Application of Fluid-Film Lubrication to Railroad Journal Bearings." All of these papers were followed by lively discussion from representatives of various railroads and oil companies.

The meeting was so thoroughly enjoyed by all that plans were laid to make it an annual event. Prof. F. G. Hechler of Pennsylvania State College was responsible for the very satisfactory arrangements for the meeting.
THE recent development of the twin motor drive for main rolls is a logical step in the modern trend toward greater mechanical simplicity of rolling mill machinery. The term "twin motor" has come to refer to a form of rolling mill drive in which each one of a pair of rolls is independently driven by a separate motor. In a true twin motor drive the motors may not operate at exactly the same speed at all times nor do they depend entirely on the coupling effect of the metal being rolled to maintain correct load division and speed relations. Independent drive for the working rolls had been used for wheel and tire mills, piercing mills, and tube expanders and reelers. In these installations the motors rotated in one direction only at practically constant speed and the metal between the rolls provided an effective coupling and rather definitely fixed the speed and load relations. Reversing beam mills with independently driven edging rolls were also in successful operation. Experience with beam mills demonstrated that the speed relations of two reversing motors working on the same piece of steel could be adjusted to take care of varying drafts with no indications of unusual roll slippage. This experience therefore formed an important step in the development of the twin motor drive. The demand for more and more power for heavy blooming and slabbing mills increased the difficulty of designing both the mechanical and electrical parts of the main drive along conventional lines and made it highly desirable to make drastic changes in the form of the drive. So now a 54-in. blooming mill and a 44-in. slabbing mill, each with main rolls driven by independent motors, are in successful operation.

When the electrical equipment for the 54-in. blooming mill first came under consideration it was felt that the continuous capacity and maximum torque of the reversing motor should be greater than anything which had been used previously, to provide power to roll heavier sections at higher tonnage rates. Accordingly both 10,000-hp. and 12,000-hp. equipments with maximum torques of 3,940,000 lb./ft. and 4,725,000 lb./ft. respectively were considered. A previous duplicate mill had been equipped with an 8,000-hp., 40 r.p.m. drive with a rated maximum torque of 2,500,000 lb./ft. For the higher motor torques it was thought that the drive for the new mill could be improved mechanically by eliminating the mill pinions. The mechanical improvement has been realized, but other advantages of the twin motor drive such as greater flexibility, greater ease of handling, lower motor inertia, higher average rolling speed and greater tonnage output so far outweigh the expected advantages that they now seem insignificant. This, of course, is the usual history of many developments.

The design of reversing equipments for continuous capacities of 10,000 hp. and 12,000 hp. at 40 r.p.m. and good for maximum torques approaching 4,000,000 and 5,000,000 lb./ft., respectively presents some interesting problems. A motor with a single unit armature would have advantages on account of its simplicity and comparatively high efficiency. The maximum capacity which has so far been built with a single unit armature is 8,000 hp. at 40 r.p.m. One such motor has an armature diameter of 180 in., which is about the maximum diameter which can be shipped in one piece. Using present design proportions, about 10,000 hp. continuous capacity at 40 r.p.m. with 3,300,000 lb./ft. maximum torque is the largest motor which could be built with a single unit armature. The inertia of such a motor would be 230 per cent of that of the 10,000-hp. twin motor drive finally adopted. So, while theoretically it may be possible to build single unit motors for much greater capacities than are now required, practical considerations such as shipping space and inertia rather definitely fix the limits of capacity which can be built in one armature.

A double armature motor offers the best possi-
bilities for a single machine of 10,000 or 12,000 hp. capacity at 40 r.p.m. With a double armature motor of this rating it is necessary to decide whether to use three generators or four generators and which one of four or five possible schemes of main connection should be employed. Even with a double armature motor the inertia is nearly twice that of a twin motor drive.

So it will be seen that the construction of the electrical equipment for a high capacity reversing drive is somewhat more complex than for small and medium ratings.

Pinion stands suitable for transmitting torques of 4,000,000 to 5,000,000 lb./ft. become very large and heavy and their design and manufacture involves serious mechanical problems. The twin motor drive therefore offered both mechanical and electrical advantages.

**Description of Drive**

The twin motor drive finally selected for the 54-in. blooming mill consists of two 5,000 hp., 40/80 r.p.m. double armature motors with a combined maximum torque rating of 3,940,000 lb./ft. Each armature is wound for 350 volts and the two armatures of one motor are connected in series, as shown in the diagram of main connections, Fig. 1 (right). The two motors operate in parallel and receive power from three 3,000-kw., 700-volt generators, connected in parallel. The motor generator has a 90-ton, 15-ft. diameter steel plate flywheel and is driven by a 6,500-hp., 368 r.p.m. induction motor.

The field circuit diagram, Fig. 1 (left), shows the system of field control. The shunt fields of each double armature motor are connected in series and in turn connected in series with the shunt field of the other motor, thus insuring the same shunt field excitation for both motors. Two shunt field exciters were employed for the motors in order to permit the use of standard 250-volt exciter generators. Also this arrangement makes it possible to vary the relative shunt excitation of the two mill motors, if necessary, by means of a buck and boost exciter connected across the midpoint of the field circuit and a point midway between the two exciters. No occasion has been found to use this latter feature. In addition to the main shunt field winding each motor has a cumulative series field and a differential series field which are cross connected and indirectly excited by series exciter generators. As shown by the diagram, the series exciter generator having its series field in the armature circuit of one double armature motor excites the cumulative field of that motor and the differential field of the other motor. Any tendency of one motor to take more than its share of the load strengthens its field and weakens the field of the other motor, thus quickly re-establishing equilibrium. A similar scheme is used in balancing the loads on the three generators of the motor generator set. The generator excitation is different in that the series fields are excited directly without the use of series exciters, and the current from one generator excites its own differential field and the cumulative field of the adjacent generator.

A valuable feature of this load balancing scheme, as applied to motors, is that any desired speed regulation can be obtained without interfering with the load balancing characteristics. Also, the load balancing effect can be varied without affecting the compounding.

The mechanical arrangement of the motors, spindles, and rolls is shown in Fig. 2. The mill rolls are normally 54 in. in diameter over the collars and the motors are mounted on 83 1/2-in. centers. The relative elevations of the motors and rolls are such that the lower spindle operates at an angle of 21/2 deg. and the upper spindle has an angle of 4 deg. below horizontal when the rolls are together and 5 deg. above horizontal when the rolls are set for maximum separation. The mill spindles are 25 ft. long, which is 4 ft. greater than for a duplicate mill with pinions. The maximum angle of the upper spindle for the pinion drive, corresponding to the same roll...
separation, is 8.5 deg. Fig. 2 shows the comparative space requirements and spindle angles of an 8,000-hp. 40 r.p.m. drive with pinions and a 10,000-hp. 40 r.p.m. twin motor drive. It will be noted that with the pinion drive the spindles operate under the most favorable conditions when the rolls are close together. The heaviest loads usually come when the ingot is large and the upper spindle considerably inclined. With twin motor drive the spindle angle is a minimum when the rolls are considerably separated, which is more nearly the condition for maximum rolling loads.

The motors themselves are mechanically duplicate. The mill end pedestal of each motor is supported on a heavily ribbed cast steel base plate. The sides and front end of the bedplate are fabricated in the usual manner from heavy beams and slabs. The upper motor drives through a jack shaft. An "A" frame on the mill end of the lower motor supports a pedestal bearing which carries the outer end of the jack shaft. The pedestal which supports the jack shaft has no thrust bearing, the thrust being taken on the mill end pedestal of the upper motor. The lower motor has the usual thrust bearing. The motor shafts and jack shaft have forged flanges. The driving halves of the universal couplings next to the motors are bolted to the lower motor shaft and jack shaft in such a way that they can be removed for renewal or repair. The electrical construction of the motor is in line with Westinghouse practice for reversing service.

Characteristics of Drive

The operating characteristics of the 10,000-hp. twin motor drive are quite different from those of a conventional reversing equipment driving through pinions. Probably the first thing which impresses an observer in the mill pulpit is the quietness of the mill. The steel enters the rolls without shock and the usual vibration and noise in the mill spindles is absent. There is practically no tendency for the mill to chatter when the steel is entered in the rolls. On this account the roller does not have to exert the usual care in entering the steel. He can enter on the first trial, even at higher speed, and therefore saves time on the early breakdown passes. With twin motor drive the phase positions of the rolls can shift independently so that they can quickly adjust themselves to the steel, thus removing the chief cause of roll chatter. On the other hand, with pinion drive the independent movement of the rolls is limited by the back-lash in the pinions and spindles. The lack of real flexibility for independent movement of these parts tends to make the chattering worse rather than to improve it. Next, the observer will note the unusually high rate of acceleration and deceleration of the mill. This is due to the comparatively low inertia of the motors, which allows the control to be designed for unusually fast field response without causing high acceleration currents and high reverse power currents. The electrical equipment is therefore used to better advantage and the capacity for useful work is increased. The rapid response of the motors makes the drive much more easily handled than the usual drive and the steel is kept closer to the mill, with the result that the intervals between passes are reduced. The increased speed of response was quite noticeable to the roller.
on the 54-in. blooming mill when the mill was first placed in operation. This roller had previously operated an equipment with a 50 per cent higher base speed, but, due to its comparatively greater inertia and slower fields, the acceleration of the older drive was noticeably slower.

The quick response of the motors increases the entering speed and average rolling speed, thereby decreasing the rolling time and increasing the percentage of time that metal is in the rolls. This effect is reflected in the increased power input necessary to keep the flywheel motor generator up to speed. An 8,000-hp., 54-in. mill drive in the Pittsburgh district has a flywheel set with a 5,000-hp. driving motor. Satisfactory operation is obtained with a slip regulator setting of 5,000 kw. When rolling the same weight ingots with the same number of passes, and with practically the same load currents, in the mill with twin motor drive, a slip regulator setting of 7,500 to 8,000 kw. is required to keep the flywheel set up to speed, when rolling at a rate which is easily maintained, showing that the rolling is done at a faster rate.

**Drive for 44-in. Slab Mill**

A 44-in. slabbing mill with twin motor drive for the main horizontal rolls has also been placed in operation recently. The design of the electrical equipment for the 44-in. slabbing mill is similar to that of the 54-in. blooming mill except that the total capacity of the drive is greater. The main horizontal rolls are driven by a 10,000-hp., 40/80 r.p.m. twin motor drive similar to that previously described. The vertical rolls are separately driven by a 2,500-hp., 79/225 r.p.m., 700-volt reversing motor. The flywheel motor generator has three 3,500-kw., 700-volt generators but is otherwise the same as the blooming mill set. The mechanical arrangement of the main mill spindles is as shown in Fig. 3.

The two equipments just described are the first installations of a twin motor drive for heavy duty mills and they have the greatest power which has so far been applied to a single pair of rolls. These two examples will serve to illustrate how the twin motor principle may be applied to drives for heavily powered reversing mills with roll diameters of 40 in. and upward. For mills with rolls 40 in. in diameter and smaller, requiring motor capacity of 8,000 hp. and less, the drive can usually be simplified by making each motor with a single armature. The motors can be mounted on smaller centers as the horsepower requirements decrease and the spindle angles can be kept within reasonable limits without the use of excessively long spindle.

It is possible from both the mechanical and electrical standpoints to build a reversing mill drive with one motor on each side of the mill. With this arrangement the diameter of the motor is not an important consideration and the motors can be designed along more conventional lines, whereas, in designing for minimum diameter, the construction may be somewhat special. However, electrical construction details within reasonable limits, are relatively unimportant as compared with other advantages of the twin-motor type of drive and the individual installation should be laid out to fit local conditions.

In recent years the conceptions of steel plant executives and engineers as to the expected output of various sizes and types of reversing mills have become fairly well standardized. Also certain standards have been applied in selecting the electric drives. Where twin-motor drive is to be used, a revision of standards will be necessary. Because of the higher average rolling speed and the reduction in intervals between passes, the capacity of a given mill is increased by a change from the conventional single motor drive to twin-motor drive. Since the electrical equipment is utilized to better advantage in the twin-motor drive, a greater tonnage output with no increase in motor capacity can be expected when this form of drive is used. However, in many cases it will be desirable to provide greater motor capacity (Continued on page 7-18)
A Thermal Study of an Open-Hearth Furnace*

AFTER having determined the radiation loss from the checker chamber loss, the volume of air entering the furnace operating under normal conditions of natural draft was readily obtained from the known quantity of heat extracted by the checkers from the waste gases, and the measured temperature rise of the air entering the furnace.

In the heat balance shown in Table II, all quantities of heat are calculated above 60 deg. F. and all temperatures are in degrees Fahrenheit. Table III is a condensed balance giving total quantities of heat and percentages based on total heat input, and also percentages based on total heat in fuel.

Discussion of Balance and Results

Heat Potential—The purpose of the regenerative system of an open-hearth furnace is to recover part of the sensible heat in the waste gases leaving the furnace and to transfer this heat to the air for combustion, thereby raising the heat potential of the furnace itself to the point where, first, it is possible to make steel and, second, it is possible to make steel in the most economical manner.

The transfer of heat from waste gases leaving a furnace to the air for combustion in a regenerative system takes place in two stages. The first stage is the transfer of heat from waste gas to brickwork of the regenerator, and the second stage, transfer from the brick regenerator to the air entering the checkers. In both cases the transfer is principally by convection.

In any reversing cycle, at the moment after reversal, a maximum temperature difference between waste gases and brickwork exists, and at that moment the transfer of heat from waste gases to brick is greatest. As the cycle progresses, the temperature difference between brick and waste gases decreases, and the rate of heat transfer from waste gases to brick falls off in the same proportion. Now, obviously, if the process were continued indefinitely, with a constant waste gas temperature, the temperature of brickwork could approach, but never attain, that of the waste gases. Actually, if a furnace was operated over a long cycle of reversal, the heat potential in the outgoing checkers would reach a maximum and then gradually fall. This falling in heat potential is due to the fact that the heat stored in the air regenerators on the incoming end is slowly exhausted and, as a consequence, the temperature of preheated air becomes lower, the flame temperature falls, and the waste gas temperature to the outgoing checker is reduced. Practical observations indicate that during an average cycle a temperature difference of at least 250 to 300 deg. F. must exist between waste gases and regenerator brickwork in an open-hearth furnace. On the reverse cycle, when air is being heated in the regenerator, the converse is true. The air temperature can never equal the temperature of the brickwork in the regenerator. Observations indicate that at least 250 to 300 deg. F. is the practical limit of temperature difference between air and regenerator temperature, so that in practice the waste gas temperature must be at least 500 to 600 deg. F. greater than preheated air temperatures and, when this condition has been obtained, increased air temperatures can result only from increased waste gas temperature.

Insulation

On the furnace used for this study, the insulation of checker chambers and careful sealing of the furnace system was done prior to the test. As a result, the general heat potential of the system was increased as shown by the fact that the temperature of the waste gases entering the checkers increased more than 200 deg. F. and of the air at the outlet of the regenerator approximately 275 deg. F.

While it is a recognized fact that on old and poorly constructed furnaces a decided improvement can be obtained by sealing and insulating the furnace system, furnaces already showing a high efficiency may not show proportionate economies. To what extent insulation of furnaces could be economically employed will largely depend upon structural and general physical conditions existing in individual plants.

Air-Fuel Ratio and Draft Conditions—Under ideal operating conditions in an open-hearth furnace it is desirable to introduce, at the incoming port, just the

*Paper presented before the American Iron and Steel Institute, at New York, May 22, 1931.
Table II—Heat Balance of Open-Hearth Furnace

<table>
<thead>
<tr>
<th>Description</th>
<th>B.t.u. in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calorific heat in coke-oven gas</td>
<td>245.559</td>
</tr>
<tr>
<td>Sensible heat in coke-oven gas</td>
<td>312</td>
</tr>
<tr>
<td>Calorific heat in oil</td>
<td>150.808</td>
</tr>
<tr>
<td>Sensible heat in oil</td>
<td>162.31</td>
</tr>
<tr>
<td>Sensible heat in steam for atomizing</td>
<td>351</td>
</tr>
<tr>
<td>Gross heat input to furnace in fuel</td>
<td>425.725</td>
</tr>
<tr>
<td>Temperature of preheated air, deg. F</td>
<td>206.2</td>
</tr>
<tr>
<td>Sensible heat in preheated air</td>
<td>90.895</td>
</tr>
<tr>
<td>Gross heat input from chemical reactions</td>
<td>368.847</td>
</tr>
<tr>
<td>Total gross heat input to furnace</td>
<td>1153.91</td>
</tr>
<tr>
<td>Sensible heat added to steel and slag</td>
<td>110.673</td>
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<tr>
<td>Heat absorbed by chemical reactions</td>
<td>14.190</td>
</tr>
<tr>
<td>Heat absorbed by combustion of H₂ (latent)</td>
<td>54.417</td>
</tr>
<tr>
<td>Heat absorbed by cooling water</td>
<td>12.606</td>
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<tr>
<td>Heat radiated from bath and port ends</td>
<td>81.145</td>
</tr>
<tr>
<td>Heat expended before entrance to checkers</td>
<td>201.823</td>
</tr>
<tr>
<td>Heat available at entrance to checkers</td>
<td>285.702</td>
</tr>
<tr>
<td>Temperature of waste gases entering checkers, deg. F</td>
<td>263.0</td>
</tr>
<tr>
<td>Heat in infiltrated air in checkers</td>
<td>19.5</td>
</tr>
<tr>
<td>Heat in waste gases leaving checkers</td>
<td>180.536</td>
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<td>Temperature of waste gases leaving checkers, deg. F</td>
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<tr>
<td>Heat in infiltrated air in flues to stack</td>
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<tr>
<td>Heat in waste gases to stack</td>
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<tr>
<td>Temperature of waste gases to stack, deg. F</td>
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<tr>
<td>Temperature of air to checkers, deg. F</td>
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</tr>
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<td>Heat in air from checkers</td>
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<tr>
<td>Temperature of air from checkers, deg. F</td>
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<tr>
<td>Heat radiated (a) from checkers</td>
<td>15.353</td>
</tr>
<tr>
<td>Heat radiated (b) from flues</td>
<td>10.979</td>
</tr>
<tr>
<td>Gross efficiency of furnace (based on gross heat value in fuel), per cent</td>
<td>27.4</td>
</tr>
<tr>
<td>Gross efficiency of furnace (based on net heat value in fuel), per cent</td>
<td>29.7</td>
</tr>
<tr>
<td>Net efficiency of furnace (based on gross heat value in fuel), per cent</td>
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<tr>
<td>Net efficiency of furnace (based on net heat value in fuel), per cent</td>
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</tr>
<tr>
<td>Bath efficiency (based on gross heat value in fuel), per cent</td>
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</tr>
<tr>
<td>Bath efficiency (based on net heat value in fuel), per cent</td>
<td>30.9</td>
</tr>
<tr>
<td>Overall efficiency of furnace (based on fuel and air), per cent</td>
<td>22.7</td>
</tr>
<tr>
<td>Overall efficiency of furnace (based on fuel), per cent</td>
<td>27.8</td>
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<tr>
<td>Gross efficiency of checkers, per cent</td>
<td>85.6</td>
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<tr>
<td>Net efficiency of checkers, per cent</td>
<td>31.5</td>
</tr>
<tr>
<td>Average B.t.u. of fuel per gross ton ingots</td>
<td>6.115</td>
</tr>
<tr>
<td>Average B.t.u. of fuel per hour</td>
<td>33.445</td>
</tr>
<tr>
<td>Average B.t.u. radiated per hour from bath and port ends</td>
<td>11.036</td>
</tr>
<tr>
<td>Gross tons of ingots per heat, tons</td>
<td>64.40</td>
</tr>
<tr>
<td>Gross tons of ingots per hour, tons</td>
<td>8.68</td>
</tr>
<tr>
<td>Time of heat</td>
<td>7 hr. 25 min.</td>
</tr>
<tr>
<td>Preheated air leaving checkers (per cent of theoretical required), per cent</td>
<td>38.17</td>
</tr>
<tr>
<td>Excess air in waste gases entering checkers, per cent</td>
<td>9.0</td>
</tr>
<tr>
<td>Excess air in waste gases leaving checkers, per cent</td>
<td>22.8</td>
</tr>
<tr>
<td>Excess air in waste gases at stack, per cent</td>
<td>72.2</td>
</tr>
</tbody>
</table>

July, 1931

Blast Furnace & Steel Plant

The prevalence of such a condition as has just been cited is becoming more and more recognized, as is shown by the improvements in construction in the most modern plants. However, the volume of air that enters the furnace system on the incoming side, under the natural draft conditions for which most open-hearth furnaces are built, depends on the temperatures existing in the checkers and uptakes, which in turn are partly regulated by the excess of air in the waste gases on the outgoing end, so that what might be termed a vicious cycle exists. Any improvement in tightness of furnace structure and adequate regulation of draft is reflected in higher waste gas temperatures, generally higher heat potential on the incoming end and, with the resulting increased draft, a greater volume of preheated air at the incoming port. This condition leads to the belief that possible economies may be obtained by the use of fans to supply the required air.

Fig. 4—DRAFTS IN THE FURNACE SYSTEM IN HEAT BALANCE TEST OF OPEN-HEARTH FURNACE. DRAFTS SHOWN IN INCHES OF WATER.
volume, particularly in those stages of the furnace campaign where the available draft is insufficient to obtain the desired results. Fig. 4 illustrates diagrammatically the average draft conditions noted in the furnace system during the test heat for which the thermal balance has been computed.

**Distribution of Heat in System**—To the open-hearth operator the fuel consumption of a furnace is expressed as millions of B.t.u. per ton of steel produced, but the distribution of this heat in the furnace system can only be brought out in a thermal balance. Some very interesting figures on this distribution are illustrated by the balance, but must, of course, be considered in conjunction with the size of the furnace and the tonnage per heat. In this particular case, with a heat of 64.4 tons, 397 million B.t.u. entered the furnace as fuel and 91 million B.t.u. were brought into the furnace with the air for combustion. In addition to this, 58 million B.t.u. were liberated as a result of the metallurgical reactions in the bath, giving in round figures a total input of 546 million B.t.u.

Of this total, 111 million B.t.u., or 20.3 per cent, remained in the steel and slag at tapping; 14 million, or 2.6 per cent, was absorbed in metallurgical reactions; 35 million, or 6.4 per cent, was absorbed in burning the hydrogen of the fuel; 19 million, or 3.6 per cent, was taken up in cooling-water; and 82 million, or 15.0 per cent, lost in radiated heat from the bath and port ends, leaving 285 million, or 52.2 per cent, to be carried into the regenerators as sensible heat in the waste gases. Of this heat entering the checkers, 105 million B.t.u., or 36.9 per cent, was absorbed by the checkers and 180 million B.t.u., or 63.1 per cent, discharged to the air. In Fig. 5 the distribution of heat in the furnace system is shown diagrammatically and the percentage figures are given in terms of total heat of fuel, rather than of total heat input.

It is quite significant that 180 million B.t.u., or 45.4 per cent of the calorific value of the fuel, and 63.1 per cent of the sensible heat in the waste gases entering the checkers was discharged into the stack and was of no further use in the metallurgical operation of making steel. This, coupled with the previously mentioned fact that only 58.2 per cent of the air for combustion entered the port, indicates that considerable economy may be effected in the more complete and efficient regeneration. The most effective utilization of the sensible heat in the waste gases involves a careful analysis of the possibilities of regeneration, together with due consideration of the advantages accruing from the use of waste heat boilers.

**Rate of Fuel Input**—During the period for which the balance is shown, no attempt was made to regulate fuel input to furnace. This was left entirely to the discretion of the furnace helper. Fig. 6 shows the total fuel input and the temperatures, volumetric and weight conditions throughout the system. Careful studies of rates of fuel on the same furnace with identical charges show a wide range of fuel input during the various stages of the heat, and leads to the belief that economies can be effected by a study of this phase of operation. Fig. 7 shows the 15-minute variation in rate of fuel input.

**Air Infiltration and Radiation**—Since the metallurgical operation of making steel must be conducted at a temperature which is close to the softening point of brick and, since large quantities of iron oxide are carried in the waste gases and come in close contact with the brick structure of the furnace proper at these high temperatures, means must frequently be provided to absorb part of this heat to preserve the furnace. Unrestricted radiation, water-cooling and, to a lesser extent, air infiltration provide the means of prolonging the life of the steel.

### Table III—Condensed Heat Balance

<table>
<thead>
<tr>
<th>Description</th>
<th>Millions B.t.u.</th>
<th>Per Cent Based on Total Heat</th>
<th>Per Cent Based on Heat in Fuel Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensible heat in air for combustion</td>
<td>90.885</td>
<td>17.52</td>
<td>29.73</td>
</tr>
<tr>
<td>Heat added by chemical reactions</td>
<td>58.384</td>
<td>10.77</td>
<td>10.62</td>
</tr>
<tr>
<td>Infiltrated air:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) In checkers</td>
<td>.195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Flues</td>
<td>.744</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>547.664</td>
<td>100.00</td>
<td>137.79</td>
</tr>
</tbody>
</table>

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**Blasf FurnaceSteel Plant**

July, 1931

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brickwork. However, in the case of many furnace structures the amount of air infiltration can be reduced, without increased repair and maintenance cost, through the regulation of the draft in the furnace. It hardly seems necessary that almost as much air should be brought into the furnace system between incoming and outgoing checkers as is brought into the furnace through the checkers. Recent attempts at automatic draft regulation have indicated some promise for their successful application. The per cent of the theoretical air requirement for perfect combustion of fuel at various parts of the furnace system are as follows:

| Per cent of theoretical air leaving the checkers | 58.2 |
| Per cent excess air, above theoretical requirements: | |
| Entering the checkers | 9.9 |
| Leaving the checkers | 22.8 |
| At the stack | 72.2 |

Radiation Loss

The extent of the losses due to radiation are illuminating: 20.59 per cent of the calorific value of the fuel is lost in radiation from the bath and port ends of the furnace; 3.86 per cent from the regenerators and 2.76 per cent from the flues after the regenerators. The following table gives the radiation figures in B.t.u., percentage of total heat input and percentage of calorific value of fuel:

<table>
<thead>
<tr>
<th>Radiation Losses</th>
<th>Percentage of Total Heat</th>
<th>Percentage of Calorific Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath and port ends</td>
<td>81.853</td>
<td>14.95</td>
</tr>
<tr>
<td>Checker chambers</td>
<td>15.353</td>
<td>2.80</td>
</tr>
<tr>
<td>Flues ............</td>
<td>10.979</td>
<td>2.60</td>
</tr>
<tr>
<td>Total .............</td>
<td>108.185</td>
<td>19.75</td>
</tr>
</tbody>
</table>

Cooling Water Losses—The losses due to cooling water in the furnace system are of only passing interest. The total loss was 19,660 million B.t.u., which was 3.59 per cent of the total heat entering the furnace and 4.95 per cent of the calorific value of the fuel. As economies are effected which raise the heat potential of the system, water-cooling (Continued on page 993)
A review of certain Gas Producer Practice

By VICTOR WINDETT
Manager Gas Producer Division
The Wellman Engineering Company
Cleveland, Ohio

PART II

A certain hesitation arises as to the present day validity of recent discussions based on conclusions drawn from age old experimentation. Cause for this arises from a comparison of conditions existing then and now in the producer gas art which are so far apart as Table IV indicates.

At present the speed of gasification and resulting functions have increased from six to ninefold, and the times of gas flow through the fire bed have decreased accordingly in recent practice. It is suggested that the thermo-chemical activity is intensified by this speeding up through heat generation in a shorter time interval, similar to that found in a blow pipe flame. It may follow, therefore, that heat losses by radiation and otherwise are somewhat lessened. In the case of these recent high rates the quality and the thermo-chemical efficiencies remain at the high values found in lower rates of working of the same type of gas producers, probably due to the speeding up.

The physical bases of such discussion are twofold, namely laboratory research, and the operation under normal working of full-sized actual gas producers. The first method is limited to a certain degree by using laboratory apparatus, working on the small scale customary in such situations, and limited by not performing under conditions which characterize actual producer operation. However, this method has certain advantages adherent to laboratory research. The other method is the study of actual full scale operation of gas producers, functioning under the conditions of actual use. By the proper interpretation and co-ordination of the results of both methods, great advances mark the design, construction and operation of the modern high-speed mechanical producer compared with the elementary producers of the older stationary hand-worked type.

It is quite true that fundamental laws correctly stated and properly understood are just as valid today as when discovered even though discovered a generation ago with the less well developed apparatus of that time.

The CO/CO₂ ratio with the thin beds reaches the value of 5, which point is not reached in the older practice until the fire is twice this thickness, according to Fig. 215 of Haslam and Russell's "Fuels and Their Combustion." The high quality of producer gas with thin beds found in present practice may be accounted for by the greater chemical activity pre-

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Table IV

<table>
<thead>
<tr>
<th>Practice Underlying Earlier Work, Still Used by Present Writers</th>
<th>Practice Obtainable Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas producers</td>
<td>Mechanical and automatic.</td>
</tr>
<tr>
<td>Coal feeding</td>
<td>Continuous, mechanical.</td>
</tr>
<tr>
<td>Ash removal</td>
<td>Continuous, mechanical.</td>
</tr>
<tr>
<td>Air delivery</td>
<td>Turbo-blower, independently controlled humidification.</td>
</tr>
<tr>
<td>Fire working</td>
<td>Continuous mechanical poking of fire. Periodic loosening to facilitate upflow of air supply.</td>
</tr>
<tr>
<td>Ash bed</td>
<td>Unworked</td>
</tr>
<tr>
<td>Producer zones</td>
<td>Total 1 ft. 3 in. up to 2 ft. 6 in.</td>
</tr>
<tr>
<td>Gasification rates, lbs./sq. ft./hr.</td>
<td>50 to 108 lb.</td>
</tr>
<tr>
<td>Ratio CO/CO₂</td>
<td>5.0 at 15 in. fire bed.</td>
</tr>
<tr>
<td>Gas velocity at offtake 1400 deg. gas</td>
<td>9.2 to 19.0 ft. per sec.</td>
</tr>
<tr>
<td>Gas flow through fire bed</td>
<td>0.3 seconds.</td>
</tr>
</tbody>
</table>
vailing, through an intensified oxygen delivery at the higher rates used.

These considerations lead to a hesitancy in accepting figures of H₂O decomposition in a producer such as

<table>
<thead>
<tr>
<th>Depth of Fuel Bed</th>
<th>Pounds of H₂O Decomposed per Lb. of Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0 ft.</td>
<td>0.36</td>
</tr>
<tr>
<td>5.0 ft.</td>
<td>0.23</td>
</tr>
<tr>
<td>3.5 ft.</td>
<td>0.19</td>
</tr>
</tbody>
</table>

unless verified by experiments made under present day conditions of gasification in a gas producer representative of the best practice.

Future Output

This review of operating rates leads to a thought as to what may be expected in the moderately near future as to gas producer output. Tentative studies have been made in this direction, reaching up to a gasification rate approaching eight or more tons per producer hour, compared with the present high figures of somewhat over 3 tons. Special circumstances may warrant in certain cases so large a unit as one handling 8 tons an hour. It is doubtful if such a jump from 3 to 8 tons will be made in one leap, for the reason that controlling the thermomechanical and attendant functions of a producer are, at present, matters of empirical experimentation, rather than office and draughting room prediction and vision. In this a producer is more like a living organism than a statically determinate machine or structure.

Although practice in this country leans to the mechanical producer, yet the final answer to the isolated cases seeking for larger units may be found in the "slagging" producer idea. In this case present limits are removed as to air supply by using blowers of the blast furnace turbine type, as to coal handling by using the skip hoist and the blast furnace revolving gas-sealed top, as to ash removal and cinder control by tapping this refuse out as liquid slag. This done and the size limit is the cost of gasification and capacity for consuming the gas.

Now it is thought that for the moderately remote future the present size of producer is about as large as the average demand calls for. Until the open-hearth executives fall in line with the uses of electricity, water and other energies of drawing their gas, water or electricity from a general main flue equipped with suitable control valves or other instruments, no open-hearth furnace will be equipped with a single producer. Prudence would forbid and good judgment would overrule "paper" estimates of the savings suggested by a single producer. Hence in the steel industry the largest producer desirable is such that in normal operation two units will serve one furnace, with a third for a standby; or two alone may be sufficient, considering final costs per ton of steel made per year. Should one of the two be down temporarily, the other could carry on at a furnace output of say 75 per cent of the normal. Other industries such as the glass, chemical, lime, brick and similar lines do not operate in such large units as to require producers beyond the present maximum possibilities. The old principle of not putting too many eggs in one basket with the attendant lack of flexibility holds strongly in the producer gas field.

The idea of duplication of plant to avoid shut down and loss of output must be held in check strongly by the opposing idea of keeping the plant investment as low as possible. Hence, the providing of spare or standby producers and duplicate gas mains must be sparingly done. The writer knows of upwards of 30 glass and chemical plants which are provided with but a single producer, in spite of the hazard of a shutdown to a glass furnace, chilling or freezing if the gas fails. Modern mechanical producer operation may be cited of two years' continuous operation with a total of four hours of lost time.

Considerable advances in open-hearth and steel reheating furnaces have been made recently in the better control of the furnace working by the intelligent study of and application of control instruments. The point of attack and control is generally that of the furnace temperatures. As to the propriety of this, there can be but little dissent, considering only the furnace. But with regard to controlling the source of heat, which is the gas producer, it is suggested that a complete understanding of the problem points to the control of the gas pressure at the gas producer gas outlet.

The best type of control instruments are of the recording type for the double reason that the trained engineer and executives can use the records for purposes of study to make further advances in his heating practice, and also that each operator knows that the impersonal autographic record of the instrument makes an undeniable record of the manner in which each man does his work. The difference in original cost of the indicating as compared with the recording instruments should not stand in the way of the purchase of the latter.

The sole function of a gas producer installation is to supply the furnaces in a more or less distant building with gas of constant and good quality, and in volumes quickly responsive to the varying demand for the heat of the furnaces.

Considering fundamentals apart from other considerations for the time being, the control of gas producer working should be in the hands of the gas makers only and no one else.

The proper co-ordination between the gas man and the furnace tender (whether he be an open-hearth melter, or helper, or a heater in charge of a reheating furnace) may be secured through the furnace man indicating to the gas house by electric push button lighting either a blue or a red electric light bulb, to call for more or less gas. At the same time the push button rings a bell to call the gas man's attention, should he not be looking at the lights. This procedure is successful practice in glass
Cooperative Research in the Iron and Steel Industry

By F. N. SPELLER

Director, Department of Metallurgy and Research
National Tube Company, Pittsburgh, Pa.

PART II

The National Federation of Iron and Steel Manufacturers, which includes practically all the iron and steel making concerns in Great Britain, is responsible for the principal cash contribution to the cost of this work, and acts jointly with the Iron and Steel Institute in furthering the work of these committees. The Iron and Steel Institute contributes a relatively small amount of money, the chief contribution to this work being materials for testing, expert advice, and labor supplied by the industry without charge to the committee.

Since the war another system for handling many kinds of industrial research has been fostered by the government under the Department of Scientific and Industrial Research, which was organized in 1916. The work done under this organization is financed jointly by the industries and the government, but the latter furnishes not more than one-half of the funds required for any project. The results of these investigations cannot be published without the consent of both the industry and the government. The organization of research work under this department of the government takes various forms in different industries.

Under this plan, any industry is entitled to form what is termed a "research association" under the auspices and regulations of the Department of Science and Industrial Research. These associations, twenty in number at present, form technical committees including representatives of the leading manufacturers of the industry and of the government. The latter has the right to withhold from publication the results of any work considered to be of national importance. The government may grant funds equal to those subscribed by the industry up to a certain amount per annum.

The "research associations" connected with the iron trade include: The Industrial Research Council of the National Federation of Iron and Steel Manufacturers, established January, 1929 (the coke research and several other technical committees of the industry are now associated with this council); the British Cast Iron Research Association, with headquarters at Birmingham; and the Refractories Research Association, with head offices in London.

The work of the Research Council of the iron and steel industry is primarily of an industrial character having to do with the application of science to the improvement of productive efficiency.

The annual reports of the Department of Scientific and Industrial Research give a brief and interesting summary of the work accomplished. Their net expenditures for the year ending March 31, 1930, for such work was £530,740 compared with £456,517 for the preceding year. The Industrial Research Council of the iron and steel industry, referred to above received £7,000 of this sum for the last fiscal year. This department now forms a center for initiating and coordinating most of the cooperative research work in Great Britain.

The National Physical Laboratory is primarily supported directly by the government, and is quite analogous to the United States Bureau of Standards. Funds are also received from both the Department of Scientific and Industrial Research and from the industry for work done on private or public problems. Many of the problems originating in the Department of Scientific and Industrial Research are handed over to this institution.

Incidentally, some of the work accomplished by the British Non-Ferrous Metals Research Association (established in 1919) is worthy of especial note. This includes new alloys for condenser tubes, improvements in lead alloys, welding of copper, and similar matters of practical interest to the industry.

American Industrial Research

The industrial research associate plans of the Bureau of Standards and the Bureau of Mines are the nearest approach we have in this country to the foreign systems by which public funds are expended on problems that are in a large part of general ben-
Co-operative research of general interest to the iron and steel industry in America is at present sponsored by various institutions including, for example, the following:

- American Society for Testing Materials
- American Society of Mechanical Engineers
- American Institute of Mining and Metallurgical Engineers
- American Welding Society
- United States Bureau of Mines
- United States Bureau of Standards
- Engineering Foundation
- American Institute of Steel Construction
- American Society for Steel Treating
- American Iron and Steel Institute, and others.

This division of control has advantages and disadvantages. The group that initiates a piece of work usually includes, or can bring together, those most interested, but there is of course a lack of general co-ordination, some duplication of effort, and occasionally differences of opinion on minor matters that tend to obscure the main objective. However, each of these groups undoubtedly has special advantages for carrying on certain investigations of advantage to producers and consumers, and it is well known that in many instances very useful work has been carried out under these auspices.

The American Society for Testing Materials has made a notable success of its study of Corrosion of Metals; the Effect of Phosphorus and Sulphur on Steel (in co-operation with the Bureau of Standards and others); their critical abstracts of work done on Fatigue of Metals; and particularly in bringing about co-operative agreement between producers and consumers in the drafting of hundreds of standard specifications for materials of all kinds, often involving a considerable amount of technical research work.

The American Society of Mechanical Engineers has done similar work on the establishment of codes for boilers and other pressure vessels; boiler furnace refractories; heavy duty-bearing metals; and has co-operated with the American Society for Testing Materials and several other societies in the joint study of Effect of Temperature on the Properties of Metals.

The Engineering Foundation, in co-operation with the American Institute of Mining and Metallurgical Engineers and the American iron and steel industry, has started to collect and investigate all data relating to alloys of iron with the following objectives:

1—To make readily available all reliable information in the great mass of literature in many languages;
2—To publish the information thus collected in two forms, one adapted to practical use in industrial plants and engineering offices, and the other convenient for researchers and teachers;
3—To correct and eliminate errors in existing data on iron and its combinations with other substances to form alloy irons and alloy steels;
4—To increase the precision of data no longer adequate to the refinements of present-day industrial processes;
5—To promote research for basic data in the metallurgy of iron, and its combinations with other substances.

This important undertaking was sponsored and financed on a five-year basis by companies associated with this Institute.

The American Welding Society has done much to develop the art of fusion welding.

The Association of American Steel Manufacturers Technical Committees has been reorganized to handle technical subjects in connection with specifications for all kinds of iron and steel products.

The United States Bureau of Standards has made useful contributions on new means of temperature measurement in steel plants, and on the problem of transverse fissures in steel rails. They have also done important work in the study of soil corrosion, referred to at greater length below.

The United States Bureau of Mines for nearly five years has provided laboratory facilities and also men, in co-operation with Carnegie Institute of Technology and a number of leading metallurgical concerns, for the study of the physical chemistry of steel making, refractories, abnormality in steel, and other problems of fundamental value, especially to the iron and steel industry. As this is one of the best and most recent examples of co-operative metallurgical research in this country and has attracted world-wide attention, a more detailed summary of this experience will be given here.

Work Started in 1923

This work was initiated in 1923 when Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, Pittsburgh, invited representatives of several industries and of the Bureau of Mines to meet together to discuss and carry on co-operative metallurgical research work in Pittsburgh. As a result of this conference an Advisory Board was organized consisting of members of the industry, the Bureau of Mines, and the Carnegie Institute. Each of the three parties represented on the Board contributed in cash or in kind toward this work.

(To be concluded in August issue)
SHIPBUILDING
and its relation to the
Steel Industry

By H. Gerrish Smith
Vice President
Bethlehem Shipbuilding Corporation, Ltd.
New York, N. Y.

PART II

The analysis shows that not less than 200 industries are directly concerned in furnishing the materials and equipment that enter into the construction of a vessel, such as that typified, and it is undoubtedly true that, directly or indirectly, almost every known industry is involved.

The actual money value of the materials and equipment required for this typical ship is $7,620,000 with a wide distribution over the United States.

The materials for this typical ship may be divided into three groups as shown in Table I. Group I consists of those materials that are almost wholly of steel or iron and includes plates, shapes, sheets, castings, forgings, pipe, rivets, bolts, wire rope, anchors, chains, boilers, and some minor items; that is, mostly raw products with very little conversion cost incurred.

Group II consists of equipment constructed largely of iron and steel, but on which considerable conversion expenditures have been made. This group includes main, auxiliary and dock machinery, refrigerating apparatus, heaters and evaporators, valves, pipe fittings and numerous miscellaneous items.

Group III not enumerated, covers all other items of material which contain little or no steel or iron.

A recapitulation shows that 33.1 per cent of the material cost is for products that are almost wholly of steel or iron, and 23.2 per cent for materials that are largely of steel or iron. A conservative estimate of the money value of steel and iron products in this typical vessel is $3,048,000, which is 40 per cent of the total material cost or 20 per cent of the total ship cost.

The transportation charges paid by the makers of materials and equipment and by the shipbuilder approximate 10 per cent of the total cost of shipbuilding, a figure that is from two to three times such costs in European shipbuilding countries where the hauls are much shorter.

The labor costs paid by the producers of material and equipment are about equal to the labor cost within the shipyard, so that about 80 per cent of the total cost involved in building a ship is expended for labor.

The facts cited as to the material requirements for vessels of special types can be supplemented by results obtained from a more recent survey conducted by the National Council of American Shipbuilders, which shows that the annual material requirements for a composite shipbuilding program of the various types and numbers of ships that must be constructed annually to maintain our present tonnage of ships of all types and sizes upon the seas in both the domestic and foreign trade. This survey included all of the important coastal shipyards of the United States and disclosed that a conservative program requires a continuous annual expenditure of $75,000,000 for new merchant ships.

Quantities and values of the many kinds of material required were obtained from actual costs on ships built and from estimated figures on other types. The costs of materials so obtained were classified into sixteen major groups. The total value of the material for this composite group of vessels is $40,264,200 or 53.7 per cent of the total cost. The largest group is machinery at a cost of $14,045,200, and the next largest group, structural iron and steel and castings, at a cost of $10,472,000.

An analysis of the machinery group indicates that at least $9,000,000 in value will be required for iron and steel products. Several of the other groups, such as metal furniture, fittings and valves, electrical equipment, galley outfit, hardware and tools, contain considerable quantities of iron and steel, so...
that a conservative estimate of the total requirement for iron and steel products in this composite program is in excess of $20,000,000 which is 50 per cent of the total material costs or 27 per cent of the total ship cost.

To obtain the total iron and steel requirements annually for the industry, there must be added to this figure the annual demands for government vessels building in both private shipyards and government navy yards, merchant vessels building on the Great Lakes and inland waterways and work in ship repair plants. These demands are estimated to be as follows:

Government work in navy yards, excluding guns and armor. $5,000,000
Government work in private shipyards. 3,000,000
Work on Great Lakes and rivers. 6,000,000
Ship repair plants. 2,000,000

The total annual demand for iron and steel products is estimated, therefore, at not less than $36,000,000.

To carry our analysis somewhat further, the character of modern shipbuilding is such that there is required in the process of ship construction, not only by the shipbuilder but by allied industries, great quantities of machinery which is mostly of iron and steel and has to be frequently replaced because of obsolescence or added to because of the development of the art. While it is not possible to express this demand for iron and steel products in money value, it is nevertheless considerable in amount.

While the total demand in shipbuilding for iron and steel products may seem small in comparison to the demands of some other industries, it should be understood that a ship is simply a vehicle of transportation and that the indirect demand, because of the trade it creates, may be many times the demand for the products used in the construction of the ship itself.

It is the history of all nations that shipping and trade are very closely associated and that those nations which have owned and operated their own vessels in the trade routes to the foreign ports of the world have increased their trade as a result of such operation. The re-establishment of an adequate American merchant marine under our own flag in foreign trade and controlled by our own nationals has been accompanied by an enormous development of this trade, particularly in manufactured and semi-manufactured machinery products.

Some indication of what the growth in this trade means to our iron and steel industry is indicated by the statement of iron and steel and machinery exports, which shows that for the year 1929 the total value of these materials, as reported by the Department of Commerce and which are largely of iron and steel, was $1,352,180,000 or nearly five times what it was in the years immediately preceding the world war and about double what it averaged for the years 1922 to 1926. While it is appreciated that the figures are higher than those for 1930, due to what we hope is a temporary depression, it seems fair to assume that they represent, nevertheless, the trend in the growth of our machinery trade, which has its corresponding effect on the demand upon the iron and steel industries of the United States.

Products of every conceivable American industry are now reaching the markets of the world and they all use iron and steel in their construction or shipment.

A Thermal Study of an Open-Hearth Furnace

(Continued from page 987)
In order to show how boiler and stove efficiencies have been improved in a relatively short time, a comparison is given in Table II of the assumed efficiencies of that paper with the actual results at Fairfield for the period of five consecutive days shown in Table I during which the power company took surplus power, based on the coke rate of 3219 lb. per ton of product.

A symbolic chart showing total hourly power production at Fairfield and Ensley, and purchase and sale of power, is shown in Fig. 7, the full lines showing conditions for the entire week, and the broken lines those for the five-day period during which the mills operated, this chart being prepared by arranging the total loads in the order of magnitude over the respective periods.

Recording charts taken for one day (September 10) in this period indicate the extent of variation in electric power conditions and in the steam and gas pressure, feedwater, and steam flow from the three

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*Contributed by the Power Division for presentation at the Semi-Annual Meeting, Birmingham, Ala., April, 1931, of The American Society of Mechanical Engineers.

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Fig. 6—Condenser auxiliaries in power house basement

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Fig. 7—Total hourly power production at Fairfield and Ensley Works, and purchase and sale of power

<table>
<thead>
<tr>
<th></th>
<th>Sept. 7-13</th>
<th>Sept. 9-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total kwh. generated</td>
<td>4,371,800</td>
<td>3,465,300</td>
</tr>
<tr>
<td>Total kwh. used</td>
<td>4,597,200</td>
<td>3,760,100</td>
</tr>
<tr>
<td>Kwh. generated at Fairfield</td>
<td>3,385,000</td>
<td>2,720,000</td>
</tr>
<tr>
<td>Kwh. generated at Ensley</td>
<td>986,800</td>
<td>743,300</td>
</tr>
<tr>
<td>Kwh. bought from Alabama Power Co.</td>
<td>534,600</td>
<td>453,400</td>
</tr>
<tr>
<td>Kwh. sold to Alabama Power Co.</td>
<td>309,200</td>
<td>188,600</td>
</tr>
</tbody>
</table>
boilers in service for this period. From these the effect of reduction of gas production at a cast period is reflected in a reduction of steam and power production, the remainder of the power requirements being made up by purchase or sale. Some coal is burned (principally during cast periods), but it is not considered advisable to maintain power production at the normal rate unless the contract limit is approached. Power is purchased on a kv.a. contract, and the generators in service are automatically regulated to maintain a uniformly high power factor on the purchased power.
The automatic control system is shown diagrammatically in Fig. 8. This system consists of several regulators, each of which has a particular function briefly discussed in the following paragraphs:

At A a master regulator operating primarily from steam pressure controls through an oil pressure system the position of a plunger at the basement level plant near the water columns are regulators operating from the combustion chamber pressure to control the speed of the induced draft fans and position of the louver dampers on the discharge of these fans to maintain practically balanced draft in the combustion chamber.

At E, similar regulators control the speed of the forced draft fan turbines to maintain constant preheated air pressure at the coal and gas burners. This pressure may be varied, but is usually kept at about 1½ in. water column.

At F, regulators control the speed of the primary air fans to maintain about 6 in. on the blast main supplying cold primary air to the coal burners.

Each of the blast furnace dust catchers has an auxiliary bleeder with the valve controlled by a regulator G to relieve gas whenever the main pressure goes over about 20 in. at the furnace.
The pumps supplying oil to the pressure system running to the several regulators in the boiler house are in the power house basement near the boiler feed pumps, and are shown at B. One of these pumps maintains about 60 lb. oil pressure on the line supplying the several regulators, the oil after use at these regulators being collected in a tank over the pumps.

By this system the combustion conditions in the boiler are maintained uniformly good, as evidenced by the low stack heats and CO₂ content of the stack gases, the latter usually above 20 per cent. The preheated air temperatures leaving the side walls are usually within 50 deg. of the stack temperatures and these are recorded by pyrometers on the same chart, and as only about 12 deg. is added to the air temperature in the side walls, the counter-current arrangement of the tubular air heater is effective.

Table II—Improvements Effected in Boiler and Stove Efficiencies

<table>
<thead>
<tr>
<th>Assumptions of paper, May, 1922</th>
<th>Results, Sept., 1930</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top temperature, deg. F.</td>
<td>400</td>
</tr>
<tr>
<td>Hot-blast temperature, deg. F.</td>
<td>1,250</td>
</tr>
<tr>
<td>Stove efficiency, per cent.</td>
<td>60</td>
</tr>
<tr>
<td>Boiler efficiency, per cent.</td>
<td>66.6</td>
</tr>
<tr>
<td>Heat in top gas per ton of product, B.t.u.</td>
<td>28,000,300</td>
</tr>
<tr>
<td>Heat required to heat blast per ton of product, B.t.u.</td>
<td>6,502,380</td>
</tr>
<tr>
<td>Heat in surplus gas after blast is heated, B.t.u.</td>
<td>21,503,920</td>
</tr>
<tr>
<td>B.h.p.-hr. per ton of product in surplus.</td>
<td>430</td>
</tr>
<tr>
<td>B.h.p. per hour per ton per day.</td>
<td>17.9</td>
</tr>
<tr>
<td>Avg. b.h.p. for tons and coke rate.</td>
<td>10,930</td>
</tr>
<tr>
<td>B.h.p. required for furnace use</td>
<td>380</td>
</tr>
<tr>
<td>B.h.p. required for blowing furnaces</td>
<td>2,830</td>
</tr>
<tr>
<td>B.h.p. required for furnaces and blowing</td>
<td>3,210</td>
</tr>
<tr>
<td>Surplus steam for power, b.h.p.</td>
<td>7,720</td>
</tr>
<tr>
<td>Kw. per hour from surplus steam at 2 kw. per b.h.p.</td>
<td>15,440</td>
</tr>
<tr>
<td>Kw.h. per ton of product in surplus</td>
<td>25.3</td>
</tr>
</tbody>
</table>

ructions, causing the turbo-generator in service to drop about 22,000 kw. and pick it up again almost immediately.

When the power load was dropped, the automatic regulation system shut off the gas and combustion air supply to the boilers and reduced the steam production to less than one-third of that carried previously very quickly, and when the load was resumed the boiler output was increased almost as quickly, with no serious loss in steam pressure.

It is the opinion of the operators that it would not be possible to successfully operate the plant without the automatic control and boiler instruments provided, and the results, as indicated by the power production, indicate the maintenance of good combustion efficiency.

In order to show the effect of the water cooling surface in the combustion chamber of the boiler, indicated that there was a very high rate of steam production in these tubes—as high as 60,000 B.t.u. per sq. ft. per hour, or from 15 to 20 per cent of the total steam production of the boiler; and as a result of employing this heat absorbing surface and the front-wall bare tubes and air-cooled side walls, practically all the brick work repairs required to date have been the partial rebuilding of the bridge walls;

(Continued on page 1001)
With the 
Equipment Manufacturer

Tube Cutting-Off Machine

THE Aetna-Standard Engineering Company, Youngstown, Ohio, has recently placed in operation a tube cutting-off machine in which they have incorporated several new features. This machine has a rather wide range of operation in that it will handle tubes from 6½ to 16 in. outside diameter.

A five-jaw chuck is used to hold the tubes in the machine. This chuck is mounted on the entering end of the spindle instead of at the cutting tool end as is usual. In order to insure absolute stability of the tube being cut a set of rounding-up blocks or clamps are placed just back of the cutting tools.

Both the jaw operating mechanism, which is of the lever and cam type and the rounding-up blocks are operated by air cylinders. The internal moving parts are lubricated by means of a spray oil system, the lubricant being forced through from a small motor-driven pump which is mounted along the side of the machine.

The cutting tools are mounted on their own carriage at the front of the machine. This carriage slides on machined steel ways being adjusted by the use of a handwheel operated rack and pinion. The tool holders themselves are moved to and away from the tube being cut by means of a variable pressure hydraulic feed, the speed of which is made adjustable to meet various conditions. The hydraulic pump, along with the motor driving it is in this case mounted directly on the cutting tool carriage thus doing away with flexible tubing or sliding joints in oil lines from the pump to the oil cylinders which are enclosed in the tool holders.

The chips from the cutting tools are gathered in a reservoir under the cutting tool carriage. Ease of access to this reservoir make the removal of these chips a simple matter. The cutting compound is also directed into this same reservoir where after passing through a series of strainers and the removal of all chips and grit it is returned to the cutting tools by its own pump.

Ease of access to all moving parts, the smoothness of operation in the cutting tools along with the rugged construction of the entire machine make this equipment extremely adaptable to all cutting operations.

Pressure Gage of Dead Weight Tester Type

DEAD weight gage tester accuracy and permanence of calibration together with unlimited power for the operation of indicators, recorders and control devices are features of the new Bailey power type pressure device. This is in effect a dead weight gage tester combined with a hydraulic torque amplifier and a Selsyn motor system of long distance transmission.

The power type pressure device is located near the pressure to be indicated or recorded. This pressure is applied by means of the pressure connection at the bottom of the device to a small pressure piston which supports a pilot valve and a cup containing mercury. This portion of the pressure device which is continuously rotated to eliminate static friction is equivalent to a dead weight pressure gage tester, as the applied pressure is counterbalanced by the weight of the rotating parts and mercury plus reaction of the displacer in the mercury. A small motor which rotates the pressure piston pilot valve and mercury cup is also used to drive a small oil pump which provides the oil pressure required for operation of the power piston, displacer and Selsyn motor.

When the applied pressure increases or decreases, the pressure piston rises or falls proportionately, and in so doing permits oil under pressure to pass through the pilot valve to the upper or lower side
J-M Insulation that cost $1675

Saves 9064 annually...

In 1928, a prominent steel company* applied Johns-Manville Insulation on the regenerator of one of their gas-fired soaking pit furnaces.

Fuel costs compared with a similar soaking pit, not insulated, show a saving of 8.5¢ per ton of ingots...a net annual saving of 89,064.40, which represents a yearly return of 541% on the investment. In other words, the insulation paid for itself in less than 10 weeks’ operation!

Other benefits directly traceable to the J-M Insulation are: (1) Better heat distribution which permits uniform checker chamber temperatures and gives the furnace operator better control over the inlet air temperature: (2) Reduction in the expansion and contraction of the brickwork which means longer life of the regenerator walls.

A "PERFORMANCE REPORT" fully describing this installation will be sent to any plant official interested.

*SNAME on request

Sides of both regenerators are insulated for their entire height with 4½" J-M Sil-O-Cel Natural Brick. The same insulation is applied to the end walls of the regenerators and to the walls adjacent to the pits as well as to the outside walls of the underground flues connecting regenerator chambers. J-M Sil-O-Cel Coarse Powder 2½" thick insulated the regenerator arches and the flues leading to the pits.

You “Pay” for insulation—whether you buy it or not

In this case, the actual fuel saved completely paid for the insulation in the first 10 weeks. Every 10 weeks since then the entire cost of the insulation has been returned as clear savings.

If your equipment needs insulation, every day you delay in buying it, the fuel you waste represents a down payment on insulation that you ought to have but haven’t—insulation that could easily be saving you money.

Call in a Johns-Manville engineer. He can show you just where insulation can reduce fuel bills. He can determine fuel savings—in advance—with a degree of accuracy that makes J-M Insulation a "sure thing" investment. Johns-Manville, 292 Madison Avenue, New York City.
of the power piston. If the pressure is increasing the pressure piston, pilot valve and mercury cup move upward, thereby throwing the pilot valve out of its neutral position and applying oil pressure to the upper side of the power piston. This causes the power piston to move downward, forcing the displacer deeper into the mercury. The reaction of the buoyant force of the mercury against the displacer will cause the mercury cup and pilot valve to be forced downward against the increased pressure under the pressure piston. This downward movement of the mercury cup, pilot valve and pressure piston returns the pilot valve to its neutral position and closes off the oil supply to the lower piston. Consequently for each pressure applied to the small rotating pressure piston, a definite position of the power piston and displacer is obtained. By driving a Selsyn motor from the rack on the power piston rod, the position of the Selsyn is an accurate indication of the applied pressure. Since the receiving Selsyn indicators and recorders assume the same position as the transmitting Selsyn, it is possible to secure accurate remote indications or records of the desired pressure.

By varying the diameter of the pressure piston, the size of the mercury cup and the size of the displacer, it is not only possible to furnish this power pressure unit for practically any maximum pressure but also for a very large suppression. The indicator shown in the illustration permits of a total pressure range of only 30 lb. for an average operating pressure of 400 lb. Since this type of indicator is 42 in. in diameter, each division which represents a pound covers considerable space on the indicating scale. Indicators of this type make ideal master pressure indicators for central station use. The possibility of connecting as many as twelve or more indicators or recorders in the same master pressure circuit makes this device a desirable means for indicating and recording master steam pressure. The Selsyn motor system of transmission which is employed by this device, permits of the installation of master pressure indicators or recorders in the control room on the switchboard without fear of leaks from pressure lines, as has been the case heretofore.

If desired, the mercury cup can be designed so that the maximum pressure can be varied within limits by the addition or removal of weights. In this case the compression is changed but the magnified pressure range remains the same.

**Micarta Roll Neck Bearings**

*By W. E. Brindley*  
*General Engineering Department*  
*Westinghouse Electric & Manufacturing Company*

**MICARTA**, a phenolic resinous material of extreme strength manufactured by Westinghouse, has given exceptional service as a bearing liner in wire, rod, bar and merchant mills. Representative installations, where the pressures are not excessive and the peripheral speeds vary from 100 to 1000 ft. per min., have shown this material to be superior to any other plain type bearing for roll neck service.

Water alone is used as a lubricant without any change in the conventional cooling system. Impure water, containing weak acids and alkalis, has no effect on Micarta and may be used without damage to the bearing. Seizing and grabbing, so common to other types of non-metallic bearings, is eliminated due to the non-absorbing and non-warping qualities of Micarta. In addition, the peculiar characteristics of the bearing material reduces scoring to a minimum. Particles of sand, grit and scale coming in contact with the surface of the bearing will imbed themselves and cause only the slightest scratching. This is due to the relatively low Brinell hardness of the material which permits charging and eliminating scoring. Micarta bearings have a slight resilience that enables them to withstand shocks and blows that damage and fatigue ordinary alloy liners.
The three essential parts of the bearing are composed of radial segments, thrust block, and housing. The radial segments usually are 120 deg. pieces so constructed that the wear at any point is at right angles to the grain of the material. The thrust block consists of a separate piece of Micarta so mounted that maximum life is afforded since the edge of the roll rubs against the grain. The thrust block and radial segments are assembled in a machined housing and are held tightly in place. The thrust collar is prevented from turning by a recess machined in the metal housing. Either the thrust collar or radial segments may be replaced independently without any special machine setup. Distribution channels are machined in the bearing surface in order that proper cooling and lubrication are afforded. A typical bearing assembly with component parts is illustrated in the photographs.

Savings in power due to the low coefficient of friction and polishing effect of the material amount to as much as 30 per cent. Additional savings are realized by the elimination of grease and oil, reduced roll maintenance and ease of replacement of either segment or thrust parts combined with long life make Micarta a desirable material for this application.

**Insulation**

The C. W. Poe Company, 7600 Caraege Avenue, Cleveland, who have been among the leaders for several years in heat insulation engineering, have recently gone into production of a plastic thermal insulation known as “Poeco.” It is claimed that this material is ideally suited to the insulation of existing furnaces, checker chamber walls, roofs and flues, as it is very high in insulating efficiency as well as extremely flexible to expansion and contraction of brickwork.

Installations on which Poeco has been tested for several months have reported unusually high fuel savings and improved working conditions. Being plastic, Poeco adapts itself readily to bulging walls and other irregularities in brickwork and seals openings against infiltration of air.

The C. W. Poe Company is represented in Pittsburgh by Pennsylvania Industrial Engineers, 414 Bessemer Building.

**The Fairfield Blast Furnace Power Plant**

(Continued from page 997)

and the total repair cost, in spite of the relatively high rating as compared with the usual blast furnace gas fired plant, has been very nominal. Photographs taken inside the boiler setting (Figs. 10 and 11) show the condition of the furnace after a usual period of service and the relatively slight deposit of flue dirt on the floor wall, side walls, and tubes.

All of the operators were taken from other plants of the Tennessee Company and had had very little, if any, experience with steam pressures over 150 lb., superheaters, turbines, condensers, pulverized coal or automatic combustion control; however, the operating difficulties encountered have been but nominal.

**A Review of Certain Gas Producer Practice**

(Continued from page 989)

factories. On receiving a call for more or less gas, the producer man responds by correspondingly altering both the rate of air and coal delivery into the producers. The lag or delay between the furnace man’s call and the response is cut to a minimum. The need of the concurrent alteration of both the air and coal feed to the producer is so elementary that it should not be necessary to more than suggest it. The reason being that each unit weight of coal must be met with its proper volume of air, otherwise the producer becomes clogged with un-reduced coal. The combining ratio for gasification is that one pound of bituminous coal calls for from 40 to 50 cu. ft. of air. A change of rate of gas demand must be met by a corresponding change in the rate of gasifying coal. This is accomplished by making a similar change of the air supply, and in no other way.

The current manner of changing the gas delivery rate to an open-hearth furnace is as different from the above as it is in error. In many such plants, it is quite customary to allow the melter to regulate the steam supply which actuates the blower of the producer. This he does by manipulating a valve of the steam line, placed for this purpose in the open-hearth building with a long steam line from the charging floor to the gas producers. That this is current practice is shown by the action of the engineer of a large steel works, who has designed in the past few months a large installation of open-hearth furnaces. He is deliberately planning for the remote producer control from the open-hearth charging floor.

(To be continued)
Cyril Ainsworth Appointed Assistant Secretary of A. S. A.

Cyril Ainsworth, safety engineer on the staff of the American Standards Association for the past year, has been appointed assistant secretary of the Association to succeed F. J. Schlink, whose resignation was recently announced.

Mr. Ainsworth came to A.S.A. from the Department of Labor and Industry of the State of Pennsylvania, where he was Director of the Bureau of Industrial Standards. Since that time he has been in charge of the entire safety code program of the Association, supervising the Association's 43 safety code projects. He is also secretary of the committees in charge of the codes for walkway surfaces and for grandstands.

One of the most important phases of Mr. Ainsworth's work with A.S.A. has been the promotion of the use of the national codes through cooperation with the groups concerned with accident prevention work, state industrial associations, technical and trade associations, casualty insurance organizations, and state commissions.

Excellent Safety Record

The American Sheet & Tin Plate Company, at its Shenango Works had, on December 17, 1930, operated 76 days without a lost-time accident among 2,500 employees. This concern experienced no accidents in the months of May, June, September, and October, 1930. The New Castle Works operated through the months of August, September and November, 1930, without a lost-time accident among an average of 1,245 employees.

Safety Campaign a Success and New Goal Set

A further reduction within the next three years of 33 per cent in the number of casualties among employees is the goal that has been fixed by the railroads of the United States, H. A. Rowe of New York, chairman of the Safety Section of the American Railway Association, announced at the recent annual convention of safety officials of the various railroads.

"This goal has been adopted," explained Mr. Rowe, "despite the remarkable safety record that has been established by the railroads in the past few years. To attain that goal, it will be necessary to obtain a further annual reduction of 11 per cent in employe casualties from 1931 to 1933 inclusive.

The railroads, through the Safety Section, in 1924 adopted a program calling for a reduction of 35 per cent in the number of employee casualties for the seven-year period ended with 1930. Due to close cooperation of the managements and the employees, the 35 per cent goal was surpassed by a large margin in 1930.

"In the basic year of 1923, there were 1,940 employees killed on duty on all railroads of the United States, while 151,960 were injured. In 1930, which was the final year of the seven-year period, fatalities among railroad employees were reduced to 935."

Liability for Injured Minor Doubled in Pennsylvania

The State Department of Labor and Industry is planning rigid enforcement of an act of the Legislature which provides that double compensation shall be paid to minors under 18 years of age injured while employed illegally, the Department has just announced. The act became effective July 1.

The employer and not the insurance carrier will be held liable for the additional compensation under the terms of the measure. It is further provided that any provision in an insurance policy undertaking to relieve the employer from such liability shall be void.

J. K. Stafford, Mississippi Valley Structural Steel Company, Decatur, Ill., chairman, Foster Committee, National Safety Council
TRADE NOTES

The Youngstown Sheet & Tube Company have placed an order with H. A. Brassert & Company of Chicago for a 40,000 C.F.M. disintegrator and one of their zoned high efficiency hot blast stoves constructed of octagonal tile with graduated inserts for their Campbell Works.

* * *

Wheeling Steel Corporation has placed an order with the Freyn Engineering Company for 10 Freyn-Design electric roll heaters and two automatic heat regulating controls for use with the same. This equipment is to be used on the sheet mills being rebuilt at the Beech Bottom Works of this company. Tokuyama Sheet Steel Company ofTokuyama, Japan, have purchased two additional Freyn-Design electric roll heaters for use in its sheet mills. In addition to this, the French and German associates of Freyn Engineering Company have sold seven Freyn-Design electric roll heaters in France and Germany during the last few months. This makes a total of 330 Freyn-Design electric roll heaters in service in sheet mills.

* * *

Mitsubishi Iron & Steel Company of Japan has contracted with Freyn Engineering Company for three Freyn-Design pressure burners for hot blast stoves for use at one of its blast furnace plants in Manchuria.

* * *

Guest, Keen, Baldwins, Ltd., of Cardiff, Wales, has placed an order for one Freyn-Design stockline recorder with Ashmore, Benson, Pease & Company, Ltd., the English associates of Freyn Engineering Company. This, together with numerous other installations made in the United States and other countries, makes a total of 65 Freyn-Design stockline recorders in service.

* * *

Gordon Fox and W. S. Orr, members of the engineering staff of the Freyn Engineering Company arrived in the United States June 19 on the S.S. Vulcana. Mr. Fox and Mr. Orr have been in the U.S.S.R. for the past ten months in connection with consultation services which Freyn Engineering Company is rendering to the Soviet iron and steel industry.

* * *

John Van Nostrand Dorr and Edwin Letts Oliver have announced a union of the businesses and assets of The Dorr Company and Oliver United Filters Inc. This union was brought about on June 1 by the formation of a new company, to be known as Dorr-Oliver Corporation, under the joint management of Messrs. Dorr and Oliver.

* * *

The Askania Corporation of Berlin, Germany have opened an American branch in Chicago at 1033 South Michigan Avenue. The above company manufacture all types of automatic pressure regulators for mixing and controlling fuels and flow of gases, as well as all types of indicating and recording meters, and geophysical instruments. The sales are being handled in this country by H. A. Brassert & Company, 310 South Michigan Avenue, Chicago.

* * *

Effective June 1, the Atlanta, Ga., sales office of Cutler-Hammer, Inc., moved to 133 Cone Street, N. W., on the street floor. These new quarters also include warehouse facilities where a stock of the more popular C-H motor control, wiring device and safety switch items will be carried for immediate delivery. A. C. Gibson is manager of the Atlanta district for Cutler-Hammer, Inc.

* * *

After 24 years of pioneering in the industrial locomotive field, Cramer & Krasselt Company advise that the Geo. D. Whitcomb Company, of Rochelle, Ill., has become a division of Baldwin Locomotive Works, with Baldwin executives as directing officials. The company will now be known as The Whitcomb Locomotive Company and will operate as a self-contained unit.

Heading the list of new Whitcomb executives is George H. Houston, president. Mr. Houston is also president of Baldwin Locomotive Works. John P. Sykes, senior vice president of Baldwin is first vice president. H. H. Perry, former vice president of the Industrial Brownhoist Corporation is vice-president and general manager, and H. V. Hulegard is sales manager. Charles E. Acker, treasurer of Baldwin is treasurer and Arthur L. Church, secretary of Baldwin is secretary of the reorganized Whitcomb Company.

Original policies established by the Geo. D. Whitcomb Company will be continued under the new management with whatever changes are advisable to increase the efficiency of the products and service.

* * *

Arthur G. McKee & Company, engineers and contractors, Cleveland, have received a contract for two McKee hot blast stoves with metal bottoms from the Youngstown Sheet & Tube Company. The improvement will be made at the C furnace, Campbell Works, Campbell, Ohio.

The McKee Company also announces further improvement in its foreign operations, the latest contract being received from Distillazione Italiana Combustibili, S.A., Venice, Italy, for process petroleum refining equipment. The new equipment will be designed to increase efficiency and capacity for existing petroleum refinery process units. This is the second contract placed by this company with McKee in the past three months.

* * *

The Blaw-Knox Company has acquired the exclusive sales and manufacturing rights of the Ateco line of earth moving machinery from the American Tractor & Equipment Company of Oakland, Calif., for the United States east of the Rocky Mountains.
and for all other countries. The line includes hydraulically operated earth movers, bulldozers, scarifiers, tamping rollers and combination outfits.

Costello Engineering Company has been awarded a contract by the Continental Steel Corporation, Kokomo, Ind., for a continuous kiln annealing furnace.

The Surface Combustion Corporation announce the closing of contracts with the Granite City Steel Company for three continuous pack and pair furnaces to be installed on their tin mills. The furnaces will be of the walking beam type having two rows operating independently with full automatic discharge features. Firing is over and under with natural gas.

Granite City Steel Company has placed in operation two continuous pack and pair furnaces on the sheet mills at North Works, which were built by Surface Combustion. This new contract, however, covers the first furnaces of this type to be installed on tin mills.

Surface Combustion Corporation has also contracted to install a tube normalizing furnace in the plant of the National Tube Company at McKeesport, Pa. This furnace will use coke-oven gas for fuel and will maintain a temperature of approximately 1650 deg. F. The maximum capacity of the furnace will be 44,800 lb. per hour and it will treat tubes up to 48 ft. in length and 18¼ in. in diameter.

Surface Combustion Corporation, Toledo, Ohio, has recently installed a carbottom annealing furnace in the plant of the St. Louis Steel Castings Company, St. Louis, Mo.

The furnace treats miscellaneous steel castings at 1650 deg. F., and the work to be treated is rolled into the furnace on a car, an electrical door lifting mechanism being at each end of the furnace. The furnace also has an electrically operated control unit, which is actuated from the heat control equipment.

The hearth or car width of the furnace is 5 ft. 6 in. and the inside width of the furnace is 6 ft. The length of the car is 7 ft. 9 in. while the length of the furnace from door to door is 8 ft. This carbottom annealing furnace has a sufficient capacity for heating 6 tons of steel castings in 6 hours, or at the rate of 2000 lb. per hour to a temperature of 1650 deg. F.

D. J. Quammen has been appointed manager of the Philadelphia district office of Cutler-Hammer, Inc., manufacturers of electric motor control and allied apparatus—whose headquarters are at Milwaukee, Wis. Mr. Quammen succeeds F. J. Burd, who has been made assistant manager of the Chicago office of Cutler-Hammer. Mr. Burd will have charge of industrial sales in the Chicago district, and of the C-H (Harland) paper machine drive throughout the country.

The hoist and crane division of Robbins & Myers, Inc., Springfield, Ohio, announces the appointment of Draflo-Doyle Company, merchants, Draflo Building, Pittsburgh, Pa., as exclusive representatives for the sale of Robbins & Myers hand and electric hoists, cranes, and trolleys in Pittsburgh territory.

The Riley Stoker Corporation, Worcester, Mass., manufacturer of combustion equipment, and The Badenhausen Corporation, Cornwells Heights, Pa., manufacturer of boilers and heat transfer equipment, have announced the consolidation of the two corporations. As a result, the Riley Stoker Corporation is now in a position to furnish complete steam generating units comprising Riley fuel burning equipment and Badenhausen boilers.

A number of installations have already been made with combined Riley-Badenhausen equipment, all of which, however, were sold under separate contracts.

Arthur G. McKee & Company, engineers and contractors, Cleveland, announce the appointment of Gray I. Morriss as sales engineer with headquarters at the eastern office of the company at 120 Broadway, New York City. Mr. Morriss was formerly connected with the American Radiator Company for many years. More recently, he was in charge of the New York office of the Kerotest Manufacturing Company.

The Morgan Engineering Company announces the appointment of Tom J. Muir as director of sales, and A. T. Davis as sales manager. Mr. Muir has been connected with the company for 29 years in various capacities, 24 years of which were in the sales department, and for the last three years as assistant sales manager.

Mr. Davis has been in the employ of the company for 19 years and for the last 12 years has been connected with the sales department.

**PUBLICATIONS**

A folder issued by the Lincoln Engineering Company, St. Louis, Mo., illustrates and describes an automatic pressure lubricating system called the Flex-O-Matic, manufactured by the company especially for use in steel mills.

The Lubricating Equipment Company, Detroit, Mich., has issued a folder on the Trabon Progressive Lubricating System. This equipment is described and illustrated.

Newhall Chain Forge & Iron Company, 9-15 Park Place, New York, N. Y., announces the publication of pamphlet No. F-9110, which illustrates a few
of the numerous types of sling chains and parts manufactured by the company.

* * *

The Brown Instrument Company, Philadelphia, Pa., has published a new catalog No. 1101 featuring a new line of potentiometer pyrometers recently introduced by this company. The catalog is a 48-page book, well illustrated. It contains a short introduction outlining the nature and field of the potentiometer principle as applied to pyrometry, shows how this principle is incorporated in the new Brown Potentiometer Pyrometer, and follows this with a concise description of more than 50 features. Many of these features are exclusive. All are novel and interesting. The instrument has a broad application to industrial needs involving the measurement and control of temperatures especially in the higher ranges. Copy of this catalog will be sent to any executive by The Brown Instrument Company, Philadelphia, Pa.

* * *

The advantages of recording automatically all fluctuations on power systems have long been recognized. Building upon the experience of many years in oscillographic development, Westinghouse now introduces a new instrument—one which has many advantages over previous designs.

This instrument is the Type PA automatic power oscillograph which is fully described and illustrated in Leaflet 20521 recently released for distribution by the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.

* * *

The Wellman Engineering Company, Cleveland, Ohio, have published bulletin No. 94 on Wellman open-hearth charging machines. This publication, consisting of 16 pages, describes the principal constructional details of the machines and is well illustrated with photographs of various sized equipment and parts. Interesting clearance diagrams are also presented.

* * *

The progress which has been made in water works pumps since the year 1913 is aptly illustrated in a leaflet distributed by the De Laval Steam Turbine Company, Trenton, N. J., describing the De Laval pumps at Ross Station, Pittsburgh, Pa. This station was originally equipped with centrifugal pumps driven by reciprocating engines, but in 1913 when the requirements exceeded the capacity of these pumps the first large geared turbine driven centrifugal water works pump built in the United States was installed.

* * *

The Cooper-Bessemer Corporation, Mt. Vernon, Ohio, is distributing a folder which contains illustrations and specifications of the new stationary Type JT Diesel engine. Bore is 11½ in., stroke 15 in. Cylinders are 3, 4, 6 or 8 in number. Rated horsepower are 150-180, 200-240, 300-360, 400-480 when operating within the speed range of 300-360 r.p.m. with cast-iron pistons. Although fuel economy, trim lines, enclosures, accessibility, and operation of built-in accessories are emphasized points—the most noticeable innovation is the placing of the spray valves and driving levers in a position directly below the cam shaft, easily reached from the engine platform. Removal of the engine head can thus be accomplished without disturbing the fuel injection system. Copies of the folder can be secured by writing the corporation direct.

* * *

The Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., announces the publication of Leaflet 20385-A, Type CS Squirrel Cage Induction Motors, which describes the new W-frame motor, which has interchangeable mechanical and electrical parts. Some of the many modifications and special applications of these motors made possible by the interchangeability of the parts are described and illustrated.

* * *

Received from the C. W. Poe Company is a small folder describing and illustrating Poeco insulating cement for covering of heated surfaces in the plant. To demonstrate the possibilities for its use, the company states its willingness to send a sample bag of the cement to interested parties.

* * *

Refractory—An illustrated booklet just published by The Charles Taylor Sons Company covers the properties and uses of P. B. Sillimanite super-refractories for boiler furnaces, heat treating and forging furnaces, crucible furnaces, enameling furnaces, electric furnaces, etc., as well as a description of pyrometer protection tubes and glass-house refractories.

### Andrews Promoted

The Blaw-Knox Company announces the appointment of Roger W. Andrews, now assistant to the president, as vice president and a director of Blaw-Knox International Corporation. Mr. Andrews will reside in Paris and will be in charge of the company's European activities, which have been growing considerably for the past few years. He will take the place of C. T. Clack, who recently died in Düsseldorf, Germany.

Prior to Mr. Andrews' association with the Blaw-Knox Company, he operated his own company under the name of Andrews-Bradshaw Company, specializing in power plant and engineering equipment, principally in the manufacture and world-wide distribution of steam, gas and air purifiers under the trade name "Tracyfiers." On January 1, 1928 the Andrews-Bradshaw Company was merged with the Blaw-Knox Company and the manufacturing and sale of the Tracyfiers was taken over by Blaw-Knox Company. Mr. Andrews was made manager of the Tracyfier Division of Blaw-Knox Company which position he held until the spring of 1929 when he was appointed assistant to the president.
Consolidation of Dolomite Inc., Cleveland, and the Dodge Manufacturing Corporation, Mishawaka, Ind., will consolidate to form the Dodge-Foote Corporation, a $10,000,000 corporation. Directors have voted for the plan but approval of stockholders is still necessary. Consolidation would be through the exchange of stock and the assumption of liabilities of both companies, requiring no public financing. Plans include a funding arrangement for the Foote Bros. obligation to banks totaling about $800,000, it is stated. Dodge Manufacturing Corporation has plants in Mishawaka and Oneida, N. Y. The activities of the plants supplement rather than duplicate each other, according to a letter to stockholders. Plans are to transfer Foote Bros. manufacturing to the Mishawaka plant of the Dodge Company. G. C. Miller, now president of Dodge Corporation, would be president of the new corporation, and J. F. Griswold, president of Foote Bros. Gear & Machine Company would be a member of the board of the consolidated company.

* * *

Consolidation of Dolomite Inc., Cleveland, and the Basic Products Company, Pittsburgh, operating two dolomite plants near Tiffin, Ohio, is announced by Howard P. Eells, Cleveland.

Basic Dolomite Inc., formed in the merger, took over operation of the former Dolomite Company’s plant at Maple Grove, Ohio, and the former Basic plant at Bettsville, Ohio, with C. V. Gallagher of Cleveland as general superintendent.

The old Dolomite management is retained intact in the new company with Howard P. Eells, president; Dan P. Eells, also of Cleveland, chairman of the executive committee. George Davison, Allen F. Davison and Albert P. Myers, former Basic Company officials, are chairman of the board, vice president and executive committee member, respectively.

* * *

National Steel Corporation has rebuilt a 10-in. strip mill at its Weirton, W. Va. plant with a capacity of 10,000 tons a month into a combination mill. It will be able to roll 7000 tons to 8000 tons a month of small merchant bars of 3/4 in. to 1 1/2 in. size, small angles and shapes, without affecting its efficiency for rolling strip.

“This change will further improve the diversification of our products. We already manufacture a wide variety of finished steel including tin mill products, sheet steel, structural material, rails, hot and cold rolled strip, wide strip, plates, blue annealed high finish sheets, merchant bars, miscellaneous sections, forging billets and sheet bars. We are continually improving the flexibility of our finishing department and the diversity of its product so that we may best meet present conditions,” John C. Williams, president of the Weirton Steel Company, National Steel subsidiary, stated in making the announcement.

* * *

H. B. Small and associates of Sharon, Pa., have purchased the plant of the American Steel Foundry Company at Sharon, which has been idle since the end of the World War, and plan to develop a new industry. Mr. Small has been general superintendent of the Wheatland Tube Company at Sharon.

* * *

The Wheeling Steel Corporation resumed operations at its Benwood plate mill June 15, following several weeks’ shutdown. Furnaces continued working in the tube department of the corporation as well as units of the galvanizing shops. The Benwood plant of the Wheeling Corporation is estimated to be operating at 40 per cent of capacity.

* * *

The Colorado Fuel & Iron Company is repairing its D blast furnaces at Pueblo, Colo. The operation will require three months and will cost $250,000. Repairs include a new steel shell, new brick lining to the furnace proper, relining of one stove and repairs to the three other stoves. The D furnace was blown in in April, 1902, and has been in practically continuous operation since.

**News of the Plants**

Gary Celebrates Anniversary

GARY, IND., celebrated the twenty-fifth anniversary of its founding on June 4. The city, which now has a population of 100,000, owes its growth almost entirely to the expansion of western subsidiaries of the United States Steel Corporation.

On what were sand dunes in 1906 are now the 12 blast furnaces, 52 open-hearth furnaces, 976 by-product coke ovens and various finishing and collateral activities of the Illinois Steel Company. Nearby are units of the American Bridge Company, American Sheet & Tin Plate Company, National Tube Company and the Universal Atlas Cement Company.

Although the Gary Land Company, Steel Corporation subsidiary, bought 10,000 acres as the site for the city, paying $5 to $2,000 per acre, it states that it has purposely operated without a profit.

William P. Gleason, superintendent of the Gary works of the Illinois Steel Company, presided at the pioneers banquet. Mr. Gleason was one of the first settlers of Gary, having aided in organizing and building the Gary works. Capt. H. S. Norton, who as agent of the Gary Land Company assisted in the development also was present.
INGOT MOLDS
OF GATHMANN DESIGN

GATHMANN INGOT MOLDS are not merely containers in which to distribute a heat of steel. They are designed for the definite purpose of producing SOUND INGOTS.

- At least 82% of the product of any Gathmann Big-end-up Ingot can be sold with the knowledge that it will meet the most exacting requirements of your customers.

- In addition to the improvement in quality of blooms and billets . . . the NET SAVINGS thru INCREASED YIELDS and LOWER CHIPPING COSTS are invariably in excess of expectations of the plant executives.

- We are glad to place our experience at the disposal of your organization. Write or 'phone us for an appointment.

THE
GATHMANN ENGINEERING COMPANY
BALTIMORE
MARYLAND
“DESIGNERS OF INGOT MOLDS SINCE 1909”

“No steel product is sounder than the ingot from which it is produced”
Fred Grotts, as of June 1, became affiliated with the Continental Roll & Steel Foundry Company, East Chicago, Ind., as metallurgical engineer, with headquarters at East Chicago and will direct the metallurgical activities of the Hubbard Steel Foundry Division, East Chicago, Ind., the Wheeling Mold & Foundry Division, Wheeling, W. Va., and the Duquesne Steel Foundry Division, Coraopolis, Pa.

Attending the University of Illinois and the University of Missouri, Mr. Grotts graduated from the latter with the degrees of Bachelor of Science and Metallurgical Engineer. For a time, he was industrial metallurgical engineer with the Public Service Company of Northern Illinois, and in 1916 went with the Curtiss Aeroplane & Motor Corporation, Buffalo, as metallurgical and chemical engineer, having technical control over all processes. For his service, he was cited by the governments of the United States, Great Britain, and France.

After the war, he joined the Caterpillar Tractor Company, Peoria, Ill., as foundry manager and technical supervisor of the plant, leaving after seven years' service to go with the American Steel Foundries, Granite City, Ill., as superintendent of wheels, the position he relinquished to make his present connection.


A. J. Ebner, mechanical engineer of Freyn Engineering Company, returned May 16 on the SS. President Harding from a four months' sojourn in Germany, England, Holland, Luxembourg and France. Mr. Ebner has been engaged on contracts which Freyn Engineering Company is executing and in investigating steel mill practices abroad.

William L. Allen, president of the Sheffield Steel Corporation, Kansas City, Mo., subsidiary of the American Rolling Mill Company, Middletown, Ohio, is reported inspecting properties of the Gulf States Steel Company, Birmingham, Ala.

Thomas Pritchard, superintendent of the A. M. Byers Company's plant at Girard, Ohio, for 30 years, has been transferred as of June 1 to Ambridge, Pa., where the company last year opened its new $10,000,000 plant for manufacturing wrought iron pipe by the Aston process.

Thomas Temple, formerly superintendent at Dekalb, Ill., for American Steel & Wire Company, Cleveland, and for more than 15 years has been
When furnace conditions are severe « «

Liptak Double Suspension Arches are the logical selection « «

As indicated by its name, the Liptak Double Suspension Arch is really two arches in one—a fire arch that is suspended from a reserve arch. The refractory structure is in turn suspended from steel work by hanger castings. There is nothing comparable with it on the market—and among its features are:

**Maximum Arch Efficiency**
Radiation loss is cut to practically nothing by the double refractory thickness (15 1/2 inches) which also stores sufficient heat to assure continuous ignition of high moisture fuels at high ratings. Air leakage is reduced to an absolute minimum since all joints are staggered.

**Longer Life**
Seven inches of fire arch can be burned away with complete safety—a reserve arch 5 inches thick remains.

**Lowest Maintenance Cost**
No castings are embedded in the fire arch and overheating of supporting members is eliminated by the greater refractory protection (12" from fire face to nearest casting). Wave line joints prevent fire arch tile from falling into furnace if neck of tile should break in service.

Bulletin No. 17 describes the other advantages of the Liptak Double Suspension Arch; many different furnace applications are also illustrated. Write for a copy.

Bigelow-Liptak Corp.
5061 Woodward Ave.
Detroit, Michigan

Sales Offices in Principal Cities

Canadian Licensees: Riley Engineering & Supply Co., Ltd., Toronto 10, Canada

Main European Office: Liptak Furnace Arches, Ltd., 38 Victoria Street, London, S. W. 1, England
superintendent at Birmingham, Ala., will on July 1
become superintendent of the company's two plants
at Joliet, Ill. Following his service at Dekalb, Mr.
Temple was transferred to Anderson, Ind., where
he served about three years and then was trans­
ferred to Birmingham.

* * *

Carl Warner, assistant superintendent of the
Mercer, Pa., works of the American Sheet & Tin
Plate Company, subsidiary of the United States
Steel Corporation, New York, has been named resi­
dent engineer of the Canton Roll & Machine Com­
pany, Canton, Ohio.

* * *

C. L. Ferguson, superintendent of the Falcon
Works of the Empire Steel Corporation has re­
signed to take a similar position with the Mahoning
Valley Steel Company, at Niles, Ohio, succeeding
Harry Davis, resigned.

* * *

R. H. Crevoisie, who recently was assistant chief
engineer of Republic Steel Corporation, Youngs­
town, Ohio, has become plant engineer at the new
wrought iron plant at Economy, Pa., of the A. M.
Byers Company, Pittsburgh.

* * *

Guy P. Shambo, with Illinois Steel Company,
since 1917, has been appointed merchant mill super­
intendent at its Joliet, Ill., works, to succeed George
Palmer, who retired May 1. Mr. Shambo has been
mechanical foreman of the merchant mill in which
capacity he was succeeded by Robert D. Bell, with
the company since 1922.

Michael Keough, who has been foreman of the
boiler shops at the coke plant, succeeds J. W. Dunn,
foreman of the boiler shops at the merchant mill,
who also retired. Mr. Keough has been with the
company since October 26, 1903. His successor is
Bernard Sheridan.

* * *

Harry L. Brindle, assistant general superintendent
of Farrell works, Carnegie Steel Company, at
Farrell, Pa., has been made general superintendent
of that plant succeeding A. L. Cromlish who was
transferred to the Duquesne works of the Carnegie
Company. Mr. Brindle was born in Sharon, Pa.
His first job was as apprentice roll turner with the
Carnegie Steel Company in June, 1907.

* * *

B. W. Norton has been appointed superintendent
of blast furnaces in the Youngstown district for Re­
public Steel Corporation, Youngstown, Ohio, suc­
ceding Chandler Markell, Cleveland, who resigned
several months ago.

* * *

C. H. Butts has been appointed vice president in
charge of operations for the Newton Steel Com­
pany succeeding C. B. Pollock, resigned. R. L.
Ritzie, manager at Newton Falls plant becomes gen­
eral manager of the Monroe and Newton Falls plants
of the company. R. M. Lanning, manager of the
Monroe plant has resigned.

* * *

Charles E. Gross, recently general superintendent
of the South Side works of A. M. Byers Company,
Pittsburgh, has been appointed general superin­
tendent of the new plant of this company at Am­
bridge, Pa. Mr. Gross has been succeeded at the
Pittsburgh plant by Amos Kamerer, formerly pipe
mill superintendent.
Double Compartment Scale Car
Capacity—15 Tons

ATLAS Products:
Storage Battery Locomotives
Electrically operated Industrial Cars
Scale Cars and Weighing Cars of all kinds
All kinds of Industrial Cars
Ore Transfer Cars and Blast Furnace Charging Cars
Pushers, Charging Cars, Door Handling Machines, and Coke Quenching Cars for By-Product Coke Ovens
Atlas Patented Indicating and Recording Mechanism

On many of the larger furnaces double compartment scale cars are found highly profitable. These cars permit the picking up of two skip loads at one trip, thereby saving time, especially in regard to spotting the car.

ATLAS Double Compartment Cars have air operated cylinders for controlling bin gates, and are equipped with ATLAS Indicating and Recording Mechanism.

Two of these cars are in use at the new furnace of the Inland Steel Company, Indiana Harbor, Ind.

The ATLAS Car & Mfg. Company
Engineers Cleveland, Ohio
Manufacturers

Uniformly Rich Gas at Low Cost
The uniform distribution of fuel in small quantities by the gas-tight coal feeder; the constant mechanical agitation of the entire fuel bed resulting in rapid gasification and the continuous ash removal which maintains the fuel bed at a constant level, are the operation features of the "WOOD" fully Automatic Gas Producers which ensure a steady flow of uniformly rich gas at low cost. As operation is automatic, labor charges are reduced to the minimum. The large gas output decreases the number of producers required. The cost of maintenance is almost negligible.

Write for full information. We will arrange for you to inspect an installation in regular operation, where these advantages will be demonstrated.

WOOD & COMPANY
PHILADELPHIA
Designers and Builders of Mechanical Gas Producers since 1889
Cause of the Breakage of Sheet Mill Rolls

By F. Johnstone Taylor

(Continued from June issue)

The fact that by far the greater number of rolls break on the first run would indicate that, provided the drafting or screwing is not at fault, the roll possesses inherent defects from the casting, because impact loads on sheet mill and tin plate rolls are really negligible. One has to consider closely the difficult conditions of cooling which occur in the seemingly simple roll casting with its hard chilled surface and soft core. In average practice the neck, for instance, has a 1.85 per cent graphitic carbon content and an 0.75 per cent combined carbon content, whereas the chill has 2.65 per cent of combined carbon and, of course, no graphitic carbon. It is exceedingly hard and brittle, whereas the remainder is soft but also brittle.

The metal cools very rapidly against the chill, whereas the innermost part cools very slowly and actual "breakouts" have occurred in the bottom of the mold leaving a complete chilled surface and soft core. In average practice the neck, for instance, has a 1.85 per cent graphitic carbon content and an 0.75 per cent combined carbon content, whereas the chill has 2.65 per cent of combined carbon and, of course, no graphitic carbon. It is exceedingly hard and brittle, whereas the remainder is soft but also brittle.

The metal cools very rapidly against the chill, whereas the innermost part cools very slowly and actual "breakouts" have occurred in the bottom of the mold leaving a complete chilled shell. One can never be sure, therefore, that the chilled portion is homogeneous with the rest. These breakouts, for instance, which are not uncommon, suggest that when the pouring of the metal has been completed, the chilled section will have solidified while the core is soft. Solidification proceeds radially and the shrinkage of the white iron envelope takes place smoothly. Solidification proceeds at a slowly diminishing rate and just a little way below the surface, the rate becomes sufficiently slow to allow of carbon being deposited in its free state and thus produce the mottled zone and subsequently the grey iron structure of the interior. The liquid metal yields to the contracting envelope of solidifying metal and it has been found that the chilled envelope of a roll casting 25 in. diameter by 55 in. long ceased to make contact with the chill, although both necks and wobblers might be still in contact with the mold. This separation of the surfaces has the effect of immediately reducing the rate of heat transfer from casting to mold and in consequence the rate of shrinkage is reduced at every point in the roll. The rate of solidification decreases, and three to seven hours, according to the size of the roll, may well elapse before the center becomes solid.

As previously shown by Fig. 1, the necks of these sheet and tin plate rolls are almost as large as the body of the roll and therefore the loss of heat must take place mainly in a radial direction. One can consider for the purpose of illustration four zones, as follows:

1—The zone of the chill and mottled iron which has solidified.
2—The zone of metal which has cooled below the first arrest temperature.
3—The zone of metal just commencing to solidify.
4—The middle mass of liquid metal.

During the solidification of (1), the metal against the mold solidifies first, and the faster rate of shrinkage of this surface metal is retarded by the slower cooling metal back of it. The different shrinkage rate across the zone will produce tension in the metal near the surface and compression in the inner metal. The stress will then reach a value equal to the pressure exerted by the liquid metal. In the radial direction, the tension in the metal near the surface will give rise to radial compression which increases from the zero at the surface to a maximum value at the no-tension point, finally reaching a value equal to the pressure exerted by the liquid metal. These conditions are, however, relieved when the temperature curve becomes less steep, following upon the heating of the face of the mold by the metal and the subsequent separation of the roll and mold faces. Differential shrinkage will take place and this will always tend to diminish the dimensions of this zone at a faster rate than the other zones. This tendency is enhanced by the greater shrinkage of white iron than of grey iron. It can be assumed, therefore, that tension will always be present in the axial and circumferential directions in this zone.

In the case of the second zone, this will probably pass through a highly viscous condition without appreciably affecting the stress condition in the outer zone.

(To be continued)
LEWIS

MAKES: Chilled iron and iron alloy rolls - Cut herringbone gears and gear drives - Worm gear units - Rolling Mills for Strip Steel, Merchant Bars, Sheet and Tin Plate and All Ferrous Metals - Shears - Roll Lathes - Rolling Mill Machinery - Neal Patent Reel for Cold Strip Reel - Special Machinery

WE WILL BE GLAD TO FURNISH SPECIFIC DETAILED INFORMATION ON ANY OF THESE PRODUCTS. SPECIFICATIONS AND PLANS ON REQUEST.

ROLL LATHES
18” TO 60”

4” x 4” BAR SHEAR

9” FOIL MILL

HIGH SPEED GEAR SET FOR CONTINUOUS ROD MILL

REDUCTION DRIVE

20” BREAKDOWN MILL

LEWIS FOUNDRY & MACHINE COMPANY
P. O. BOX 1591
PITTSBURGH, PA.
Refractory Bulletin

The U. S. Bureau of Mines has just issued Bulletin No. 334, entitled "A Study of Refractories Service Conditions in Boiler Furnaces," summarizing a field investigation that it has conducted over the past five years for the A.S.M.E. Special Research Committee on Boiler Furnace Refractories. The results of studies made at various power stations, representative of the use of a given class of fuel with a certain type of equipment, have been co-ordinated and generalized. The bulletin is well illustrated with cuts of the apparatus and instruments used, and with a number of photographs of the interiors of furnaces. The majority of the results are presented graphically in forms of curves which are easy to follow.

Bott Transferred to Ohio Works

Frank Bott, for several years superintendent of masonry at the Clairton plant of the Carnegie Steel Company, has been transferred to the Ohio Works, Youngstown. He will fill the position of Master Mason made vacant by the retirement of James Cooper.

Revised Refractories Film Available

The manufacture and application of fire clay products is shown in an instructive way in the moving picture film "Fire Clay Refractories," recently revised to cover improvements in technology made since its production in 1923 by the U. S. Bureau of Mines in co-operation with the Laclede-Christy Clay Products Company, St. Louis. The photography is of the highest quality and the film has met with the enthusiastic reception of a number of audiences. The picture is three reels in length and requires about 45 minutes for a showing.

New Refractory Plant

The Harbison-Walker Refractories Company, Pittsburgh, Pa., has had plans prepared for the erection of a new plant unit at Galia and Campbell Avenues, New Boston, near Portsmouth, Ohio, to be equipped for a capacity of about 18,000 fire brick daily.

Correspondence on Sillimanite

We are pleased to publish a letter received from M. C. Booze, vice president of the Chas. Taylor Sons Company, regarding an article which appeared in the June issue of Blast Furnace and Steel Plant.

Gentlemen:

We have just read an article entitled "Use of Sillimanite as Material for Furnace Covers" in the last issue of Blast Furnace and Steel Plant, which contains information that is apt to be misleading and which accordingly deserves correction.

This article points out that sillimanite is unsuitable for use in electric furnaces on account of the fact that it was more costly than silica brick and gives approximately the same life.

There are at least five direct arc electric furnaces operating in this country at the present time with tamped roofs made of P. B. Sillimanite and a much larger number of the indirect arc type having complete tamped sillimanite linings. In one case, a direct arc furnace, which was operated intermittently, had an average roof life of about 35 heats when using silica brick. A tamped sillimanite roof had been on the furnace for 429 heats at the last report and had lost approximately 20 per cent of the original thickness. In another case, a roof after 100 heats had shown very little wear, except around the electrode openings, which were easily repaired, and with this life has shown economy over silica and diaspore refractories.

In the case of the indirect arc furnaces, rammed sillimanite linings have shown distinct economies on account of long life and freedom from maintenance expense. Sillimanite roofs for direct arc electric furnaces show economies for other reasons than the number of heats. They permit rapid heating up of the furnace with a minimum of spalling and result in power savings; pouring metal at higher temperatures than are possible with silica roofs and less slag over the metal.

The sillimanite mixtures used for the tamped roofs in the article referred to are, in our opinion, of unsuitable composition for the service involved. In the first experiment, the bond content of 2 per cent was insufficient to provide satisfactory strength and in the second experiment, the grain size of the sillimanite used, we believe,
Application of IMPROVED Lavino Chrome Brick in Basic Open Hearth Furnaces

We recommend IMPROVED Lavino Chrome Brick in the bottom, end slopes, monkey walls, front walls and back walls, which conforms with the generally accepted standard of good construction throughout the industry.

Depending on furnace design and operating conditions, IMPROVED Lavino Chrome Brick can be economically used in ports, uptakes, and end panels.

Secure greater economies in the construction and maintenance of your basic open hearth furnace through the use of IMPROVED Lavino Chrome Brick.

The IMPROVED Lavino Chrome Brick has the following outstanding advantages:

- Less spalling and cracking. (Tests show the spalling loss of these IMPROVED Brick to be 75% less than any other Chrome Brick).
- Greater resistance to penetration of destructive elements.
- Higher hot load strength.
- Much greater resistance to abrasion and erosion.
- A sagging point 300° F. above any Chrome Brick heretofore produced commercially.

Write for samples and further information.

Consult one of our refractories engineers on all new applications of IMPROVED Lavino Chrome Brick. Our men are trained to recommend only applications which can be supported by laboratory or performance records.

E.J. LAVINO AND COMPANY
REFRACTORIES DIVISION
CHROME, MAGNESITE AND SILICA REFRACTORIES
BULLIT BLDG. PHILADELPHIA

"Pioneers in Chrome Refractories"
is quite unsatisfactory as determined by our own experience.

Judging from the fact that an average of 33 heats was obtained on the silica roof used on the German furnace, it is quite probable that the furnace operating conditions were abnormal and extremely severe, as there are many furnaces in this country of the same size and larger, showing very much greater roof life with ordinary silica brick.

A Study of Refractory Materials*

By Colin Presswood
B.A., F.G.S.

Part II

Typical figures are shown in Table I, which includes a variety of brick types, and from the variation of conductivity with temperature the desirability of always noting temperature at which a figure was determined will be apparent.

Interest in thermal conductivity centers chiefly around fuel saving, and figures are particularly valuable for insulating bricks. (See later section.) Whether insulating layers are used or not, the fire bricks exert considerable influence, and, there being no opposing consideration, the least conductive bricks should be used. When a refractory wall is backed up by diatomaceous insulating bricks its conductivity is a guide to its thickness, since the higher the figure the greater the thickness necessary to protect the diatomite from excessive temperature.

Conductivity has a distinct influence on spalling, which is dealt with below.

The electrical properties of refractory materials are not widely known, nor are they, in general, nearly so important as the properties previously mentioned. Conductivity is to be considered, however, in electric furnaces, and in the manufacture of heating elements in which wires and rods are embedded in a refractory cement.

In general, refractories are good resistors at moderate temperatures, but nearly all show a big drop in resistance at 1,400 deg. C. to 1,550 deg. C. Thus, Diepschlag and Wulfestieg show that resistance of MgO in ohms per c. cm. falls from 158,000 at 1,100 deg. C. to 1,105 at 1,550 deg. C. King shows that periclase has infinite resistance over the range 713 deg. C. to 990 deg. C. (Journal American Ceramic Society, June, 1926). He finds sillimanite resistance infinite at 713 deg. C., but 124,000 at 990 deg. C.

Chrome bricks have poor resistance, and a cement with chrome ore as base has certainly failed when used for embedding nichrome wires, though in this case there were, no doubt, chemical reasons for the failure. Pure silicon carbide, first-grade fireclay bricks, bauxite bricks, and lime-bonded silica bricks have shown regular resistance curves.

Diepschlag and Wulfestieg give the following results for pure minerals:

Table II

<table>
<thead>
<tr>
<th>Material Tested</th>
<th>1100 °C.</th>
<th>1250 °C.</th>
<th>1400 °C.</th>
<th>1550 °C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MgO</td>
<td>158,000</td>
<td>16,395</td>
<td>2,500</td>
<td>1,105</td>
</tr>
<tr>
<td>SiO₂</td>
<td>161,000</td>
<td>41,320</td>
<td>12,600</td>
<td>5,950</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>133,100</td>
<td>58,000</td>
<td>12,000</td>
<td>4,080</td>
</tr>
<tr>
<td>CaO</td>
<td>117,740</td>
<td>34,180</td>
<td>10,180</td>
<td>830</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>434</td>
<td>423</td>
<td>336</td>
<td>99</td>
</tr>
<tr>
<td>Mn₃O₄</td>
<td>710</td>
<td>603</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Specimens were reduced.

They dealt principally with commercial magnesite and found that:

(a) The addition of MgO, SiO₂, and CaO reduces

<table>
<thead>
<tr>
<th>Brick</th>
<th>Thermal conductivity cgs. units</th>
<th>Temperature at which test was made deg. C.</th>
<th>Authority</th>
<th>Representative figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Diatomite insulating brick</td>
<td>0.000260</td>
<td>162/6</td>
<td>N. P. L.</td>
<td>1</td>
</tr>
<tr>
<td>2—Diatomite insulating brick</td>
<td>0.000390</td>
<td>617/00</td>
<td>N. P. L.</td>
<td>1½</td>
</tr>
<tr>
<td>3—Fire clay brick, Missouri</td>
<td>0.000260</td>
<td>750</td>
<td>Norton</td>
<td>9</td>
</tr>
<tr>
<td>4—“Fire brick”</td>
<td>0.0042</td>
<td>1400</td>
<td>Norton</td>
<td>16</td>
</tr>
<tr>
<td>5—Silica brick</td>
<td>0.00135</td>
<td>800</td>
<td>Green quoted by Norton</td>
<td>5</td>
</tr>
<tr>
<td>6—Chrome brick</td>
<td>0.00206</td>
<td>1000</td>
<td>Norton</td>
<td>8</td>
</tr>
<tr>
<td>7—Magnesite brick</td>
<td>0.0028</td>
<td>200</td>
<td>Norton</td>
<td>11</td>
</tr>
<tr>
<td>8—Silicon carbide brick</td>
<td>0.0034</td>
<td>1400</td>
<td>Norton</td>
<td>16</td>
</tr>
</tbody>
</table>

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Several years ago we developed and patented an entirely new type of super-refractory, called Corhart Electrocast.

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We do not claim that Corhart Electrocast is a "cure-all". We do say, however, that Corhart possesses a unique combination of characteristics that make it ideally practical and economical for several kinds of super-hard service.

If you have a severe or troublesome application for refractories, write for Bulletin 51-I. It gives an accurate and conservative statement of the proven facts. No obligation—no high-pressure "follow-up". Address: Corhart Refractories Co., Incorporated, 16th and Lee Streets, Louisville, Kentucky.

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Withstands Temperature Changes. . .
resistance at 1,100 deg. C. and 1,250 deg. C.; increases resistance at 1,400 deg. C. and 1,550 deg. C.
(b) The addition of Fe₂O₃, and Mn₃O₄ reduces resistance at all temperatures.
(c) Fine grain size and increased pressure reduce resistance.
(d) Unstable mineral systems show most irregular results, but better regularity can be obtained if specimens are held at high temperatures for a long time before being tested. This points to the need for thorough heat-treatment in manufacture.
(e) Resistance curves for magnesite are very irregular as the commercial mineral is not homogeneous.

For magnesite bricks they gave the figure of approximately 76,000 ohms per cu. cm. at 1,100 deg. C., which falls to less than 100 ohms per cu. cm. at 1,550 deg. C.

Spalling Tests

Spalling, or the cracking of a brick when its temperature changes, probably causes more damage than any other factor operating during use. The bricks may either crack into fairly large pieces which become detached, or the face only may become friable and small particles fall off as coarse dust. Primarily, the trouble is due to expansion and the inability of the brick to withstand the consequent stresses.

The consolidation of a refractory brick is effected by surrounding assorted sizes of relatively coarse, highly refractory grains with a thin film of material less refractory. This material—a mild flux—may be added deliberately—e.g., lime in silica bricks, or may be incidental to manufacture. Thus, in grinding, infinitely small grains of the refractory surround the coarser grains and, because of their fineness, melt more easily than the coarse grains. The brick, therefore, comprises more or less coarse grains cemented together by material which has been semi-fused to form a "glass." This "glass" is often highly sensitive to temperature changes, and cannot withstand expansion stresses, if these are applied suddenly. The object of the brick manufacturer is to produce no more "glassy matter" than is consistent with a hard brick. Bricks which are overburnt or vitreified may spall badly when the same material reasonably, or under, burnt, will resist spalling.

(To be continued)

Twin Motor Drive for Main Rolls

(Continued from page 983)

in order to take advantage of all the possibilities for increased output.

The principal advantages of the twin-motor drive for reversing service can be summarized as follows:

1—The motor capacity which may be applied to a single pair of rolls is greatly increased.

2—Pinion losses, repairs and maintenance are eliminated.

3—The motors may be designed to have greatly reduced inertia; resulting in less strain on the equipment, more torque available for useful work, reduced motor and generator heating and faster acceleration.

4—Roll chatter and spindle vibration are practically eliminated.

5—Higher rolling speeds can be maintained and mill tonnage can be increased.

The relative first costs of twin-motor reversing drive and pinion drive will vary with the size and torque requirements of the mill. The two motors of a twin-motor drive with the necessary shifting and bearings are more expensive to build than a single motor of equivalent capacity. This increased cost may be somewhat less than the cost of a pinion stand with spare pinions and bearings in the case of a heavy mill and somewhat greater for a light mill. In general, the difference in cost is not great and is a minor consideration as compared to the advantages of twin-motor drive.

Twin-motor drive offers advantages for wide strip mills, both for hot rolling and cold rolling. The chief advantage is that the elimination of the mill pinions does away with the necessity for accurate matching of the mill rolls. In either hot rolling or cold rolling, unless the rolls are very accurately matched, extremely high stresses are set up in the pinions to cause the larger roll to slip and equalize the delivery speeds. With twin-motor drive the motor speeds easily adjust themselves so that each roll has the same surface speed. The problem of load division is quite simple, as wide thin material forms practically a 100 per cent coupling between the rolls.

The simplest form of drive for a strip mill is a direct-connected motor on either side of the mill; each motor driving one working roll. This arrangement may be objected to, especially for hot mills, on account of the space taken up by the motor and spindles on the side of the mill which is usually left open. This objection can be overcome by the use of special gearing which will permit the installation of both motors on the same side of the mill. Such an arrangement introduces no new mechanical complications, because it is now customary to use geared motors with pinion drive and the total number of gear units would remain the same. Instead of a reduction unit and a mill pinion unit, each of full capacity, there would be two reduction units each of half the total capacity.
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Sfool Plan!

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FIRST QUALITY
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Climax, Penna.

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Without Shutting Down

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Use—Apply while furnace is hot.
Result—Lower furnace cost.

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Allentown, Penna.

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#### Draft Fans.
- Air Preheater Corp., The

#### Drawbenches, Tubes and Bases.
- Aetna-Standard Engineering Co.

#### Driers—Direct Heat.
- Combustion Engineering Corp.
- Fuller Lehigh Co.

#### Driers—Indirect Heat.
- Combustion Engineering Corp.
- Fuller Lehigh Co.

#### Driers—Rotary.
- Combustion Engineering Corp.
- Fuller Lehigh Co.

#### Drives—Chain.
- Link-Belt Co.
- Morris Chain Co.

#### Drives—Gear, Rope.
- Gears and Forgings Inc.
- Link-Belt Co.
- Mesta Machine Co.
- Poole Engineering & Machine Co.
- Robins Conveying Belt Co.

#### Drives—Mill.
- Birdshoe Steel Fdry. & Mach. Co.
- Gears and Forgings Inc.
- Lewis Foundry & Machine Co.
- Link-Belt Co.
- Mesta Machine Co.
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- National Roll & Fdry. Co.
- Poole Engineering & Machine Co.
- Robins Conveying Belt Co.

#### Dynamometers—Gas Engine Testing.
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#### Dynamometers—Gas Engine Testing.
- General Electric Co.

#### Engines—Consulting.
- Braseart & Co., H. A.
- Freya Engineering Co.
- McKe & Co., Arthur G.
- Morgan Construction Co.
- Murray Inc., Thomas E.
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- Rockwell Co., W. S.
- Shover, Barton R.
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- Bartlett Hayward Co., The
- Freya Engineering Co.
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#### Engines—Corliss.
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#### Engines—Gas.
- Mesta Machine Co.
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#### Engineers—Hoisting.
- Mesta Machine Co.
- Treadwell Engineering Co.

#### Engineers—Steam, Unflow.
- Mesta Machine Co.

#### Equipment—Welded Chain, Wire and Wire Nail Mills—Complete.
- Morgan Construction Co.

#### Evaporators—Multiple.
- Bartlett Hayward Co., The
- Treadwell Engineering Co.

#### Extractors—Tar.
- Bartlett Hayward Co., The
- Western Gas Construction Co., The

#### Fast’s Flexible Couplings.
- Bartlett Hayward Co., The

#### Feeders—Pulverized Coal.
- Combustion Engineering Corp.
- Fuller Lehigh Co.

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- Robins Conveying Belt Co.

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- Electro Metallurgical Sales Corp.
- Lavio & Co., E. J.

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- Morgan Engineering Co., The

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- Morgan Engineering Co., The

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- Morgan Engineering Co., The

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National Roll & Foundry Co.

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### Buyers Guide

#### Blast Furnace & Steel Plant

**July, 1931**

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...simply because AETNA-STANDARD machinery and equipment is designed and built in the belief that the best of material and workmanship is none too good for the work it has to do.

... simply because these mills...like the Billet Mill shown here, one of the fastest mills of its kind... are built not only for today but for tomorrow as well.

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ROLLING MILLS . . . Seamless Tube Mills, Blooming Mills, Billet, Bar and Rod Mills, 4-high Strip Mills, Rail, Structural and Universal Mills, Tin and Sheet Mills.

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**AETNA-STANDARD**

ENGINEERING CO., YOUNGSTOWN, OHIO

Our business is designing and building machines for the rolling and finishing of steel...
Heat doesn’t leak through the wall of Nonpareil Insulating Brick around this annealing furnace of Timken Roller Bearing Co., at Canton, Ohio.

**TIMKEN'S EXPERIENCE**

**has a bearing on FURNACE INSULATION**

Fifty tons of seamless steel tubes are annealed at one time by Timken in an 850 K.W. pit type furnace. Nonpareil Insulating Brick help hold the temperature constant during this annealing process.

The reason why Timken Roller Bearing Company, and many other metal working plants, choose Armstrong's and Nonpareil Insulating Brick is expressed in one word: economy. The first saving is in fuel. Records show these brick reduce fuel consumption as much as 10% to 40% a year. Fully as important is the effect on production processes. Constant temperatures, maintained by proper insulation, help to produce a uniformly satisfactory output.

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OPERATED BY HENRY L. DOHERTY & COMPANY

Surface Combustion

SURFACE COMBUSTION CORPORATION
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**Oxwelding Has Become Standard Practice**

Architects and engineers have been quick to appreciate the inherent advantages of oxwelding as applied to modern piping services. On its record of proved performance, this method of pipe jointing has gradually become the standard practice in many fields and is constantly gaining further recognition. In high pressure work it is the only means of satisfactory construction at moderate cost.

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Under Procedure Control, welded piping construction may be undertaken with the same confidence in a satisfactory result as older methods, and with further assurance of increased economy and serviceability.

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**WELDED TEE AND BRANCH CONNECTIONS**

*Explanation of Design:* Oxwelded tee fittings, crosses and branch connections, of either equal or unequal diameters, can be fabricated from standard pipe by cutting with the oxygen-acetylene blowpipe and welding to form the finished fittings.

*Uses:* Oxwelded Tee and Branch Connections can be used for all sizes and services to replace standard or special fittings commonly used in piping systems.

*Specifications:* When Oxwelded Tee and Branch Connections are specified, the following features should be included in the specifications:

1. Templets shall be used for making cuts.
2. Center lines shall be marked and matched in assembly.
3. When beveled with the blowpipe, the cut edges shall be thoroughly cleaned of slag before welding.
4. Cuts shall be carefully beveled and accurately matched in order to form a good vee for welding.
5. Welds shall be built up to a thickness of at least \( \frac{1}{2} \) to \( \frac{3}{4} \) times the pipe wall thickness and form a gradual fillet between the branch and header.
6. The weld shall be of sound metal free from laps, gas pockets, slag inclusions or other defects.

The above is excerpted from a handbook of fundamental designs, titled "Design Standards for Oxwelded Steel and Wrought Iron Piping," published by The Linde Air Products Company.

You should have a copy of this handbook. It is yours for the asking.

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The Porter Line consists of standard Steam, Gas-Electric, Oil-Electric and Fireless Locomotives—each one built to give the most service and economy in the field for which it is particularly adaptable.
CUTTING STEAM COSTS 
IN THE STEEL INDUSTRY

In the plants of these companies, steam generating units totaling over half a million rated boiler horse-power comprise or are served by these Combustion Engineering products.

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The Mantle recuperator is COMPLETELY ACCESSIBLE FOR INSPECTION AND CLEANING... which reduces maintenance costs to a minimum. The recuperator is entirely independent of the furnace and becomes a valuable separate accessory, rather than a part of the furnace itself.

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FUEL SAVING 34 PER CENT.

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REVERSE!
ON TEMPERATURE CYCLES

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Open Hearth
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Bristol’s Automatic Reversing Controller
With Visible and Audible Signals

is showing the way to new economies in the operation of all types of reversing furnaces. Dependable, rugged equipment, maintaining uniform TEMPERATURE limits (not arbitrary time cycles) is proving a revelation in many modern plants. Have a Bristol engineer explain this system to you.

The Bristol Company • Waterbury, Conn.
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Blast Furnace Gas is our Most Valuable Fuel—B.T.U. for B.T.U. and should be utilized to the fullest extent.

We would like to show you the great economies which can be effected with the use of CLEAN BLAST FURNACE GAS in hot blast stoves, open hearth furnaces, soaking pits, and heating furnaces.

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1. The two hubs carry generated spur gears.

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**Fast's Floating Shaft Type Coupling Connecting Gear and Steel Mill Drive at the Bourne-Fuller Company, Cleveland, Ohio**

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*Fast's Self-Aligning Coupling*

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**JUST GIVE IT OIL**

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**--it Stays Clean**

YOU need never worry again about dust, dirt, flying abrasives, or moisture getting into a flexible coupling, wearing it down, reducing efficiency, and quickly sending it to the scrap heap.

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This exclusive, patented, metal-to-metal seal, proved by long years of service, explains why Fast's Couplings "last as long as the connected machines!"
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Convention Number
of Heat Treating and Forging

THE September issue of HEAT TREATING AND FORGING will this year be outstanding in several particulars. It will contain at least ten articles from men who have achieved unusual prominence in the forging, heat treating, steel making or furnace building industries. Among the contributors will be such well known authorities as:


In this issue Professor W. Trinks, whose work as a combustion engineer is so well known that it requires no comment, will publish the first of a series of articles on furnace design and operation. Another series of articles that will have its beginning in the September issue is one that will possess a particular appeal to the practical foreman. This series will cover the working of drop forgings from the steel in bar form to the finished product.

The attractiveness of the magazine will be further enhanced by numerous and carefully selected illustrations. Copies of the September issue will be distributed from the booth of Steel Publications Inc. at the Annual Exposition of the A.S.S.T. to be held in Boston, September 21.

Make your reservation for space in this impressive September Convention Issue of
Heat Treating and Forging
—the only A.B.C.-A.B.P. publication in its field.

Do it NOW!

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108 Smithfield Street, Pittsburgh, Pa.
You get greater Hauling Capacity and quicker acceleration

In dynamometer car tests, and also in switching service, the 60-ton HEISLER Oil-Electric has fully demonstrated its ability to develop above 48,000 lbs. of tractive effort with ease.

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The remarkable performance of the HEISLER Oil-Electric is secured with extremely simple, sturdy, flexible and well balanced construction and equipment.

If you are interested in the money saving advantages of Oil-Electric or Gas-Electric power, it will pay you to carefully investigate the performance and construction of this locomotive.

Descriptive data will be furnished gladly, upon request. Write for it.

HEISLER LOCOMOTIVE WORKS
Erie, Penna., U. S. A.
Steam Geared
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The HEISLER Oil-Electric
Equip Your Cupolas with Hot Blast

—You can then SAFELY cut under prices quoted by a foundry with cold-blast cupolas, walk away with the orders, and still make a handsome profit.

In times and locations of keen competition, this change-over, with a resulting saving of at least 25 per cent in coke and limestone for every ton of iron melted, is the best counterbalance against the low prices you must meet. Hot-blast cupola operation cuts the other costs substantially in times of small production when overhead keeps on just the same, tides you over, puts you in a position to make big profits on return to normal production, and when a rush comes, gives you the extra capacity to deliver more first-class castings than ever before.

A foundry with cupolas served by the Griffin Hot-Blast Process melts 150 tons or at least 135 tons of iron without consuming more coke than cold-blast cupolas require to melt 100 tons, saves also the labor and power used to handle and charge the additional coke and limestone, and produces better castings with fewer rejections.

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The initial installation, operating and maintenance costs for the Griffin Hot-Blast Process are so small that every installation to date has returned annually at least 50 per cent net cash on the investment.

Write for booklet “The Griffin Hot-Blast Process” or give us details about your present cupolas, operating periods, capacity, etc., so that our Engineers can submit cost and operating data, guarantees, and proof of profitable performance.

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Works: Wellsville, N. Y.; Agents in Boston, Buffalo, Chicago, St. Louis, Charlotte, Detroit, Philadelphia, Cleveland, Indianapolis, Minneapolis, New Orleans, Pittsburgh, Cincinnati, San Francisco, Tacoma, Kansas City, Ft. Worth, Houston, Denver, Salt Lake City, Los Angeles, Portland, Spokane, Seattle.

The Griffin Hot-Blast Process
AT THE DOW CHEMICAL COMPANY

The power generation problem at the Dow Chemical Company's Midland, Michigan, plant is one of continuous high capacity and high load factor operation.

Boiler No. 6 at this plant is served by complete Fuller Lehigh coal-pulverizing and burning equipment, and Bailey Water-Cooled Furnace Walls.

Write for literature describing many successful applications of Fuller Lehigh pulverized-coal burning systems in public utilities and industrial power plants.

FULLER LEHIGH COMPANY
A Babcock & Wilcox Organization
85 LIBERTY ST., NEW YORK N.Y.

FULLER LEHIGH
PULVERIZED-COAL EQUIPMENT — WATER-COOLED FURNACE WALLS
This view is of another Robins designed and equipped handling system. Robins Conveyors in the Indiana Harbor plant of The Youngstown Sheet & Tube Company.

1 100% Conveyor-Handled
2 Elimination of Larry Cars
3 Stock Reserves at the Skips

Three Pioneering Material-Handling Features at a Large Blast Furnace Plant

Not long ago a large steel company instituted some radical changes in the ore, flux and coke handling at its blast furnaces. With the exception of steel apron feeders for delivering manganese and flux to the weigh-hoppers, belt conveyors handle all the material throughout the plant. This, in itself, is an innovation.

Another feature is the method of loading the skips. Each skip has its series of bins for ore, coke, flux and manganese. Under the bins, suitable feeders deliver the respective charges to the weighing hoppers which in turn deliver direct to the skips. Not only is the proportioning more accurate but the handling simpler and automatic. Full accuracy at sustained high capacity is more easily maintained than by the use of lorries.

The third feature of importance is that each skip has ample supplies right at hand in its stock bins. For many hours of operation the skips are independent of the main stock piles.

Robins engineers collaborated with the steel company engineers in working out the scheme, and handled the complete design. Robins belt conveyors, feeders, and weigh-hoppers are used throughout.

ROBINS CONVEYING BELT COMPANY
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ROBINS
EQUIPMENT
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Published the first of each month by Steel Publications Incorporated
Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.

DON N. WATKINS, President  D. S. WATKINS, Vice President
EASTERN MANAGER  ROBERT E. POWELL
29 West Thirty-fourth Street New York, N. Y.

WESTERN MANAGER  GLEN W. NEELY
105 West Monroe Street Chicago, Ill.

Subscription Price:—In the United States, $2 per year; Canada, $2.50; all foreign countries, 15 shillings. Single Copy 55 cents. Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.
CASTINGS
OF QUALITY AND CHARACTER
for RESISTING HEAT AND CORROSION

especially designed to meet a specific condition and having the structural characteristics and accuracy of form to perform a definite service.

The above castings are interesting, showing the front and back view of seemingly a rather intricate design. These views speak for our organization as well as for our products and will doubtless excite comparison.

MICHIANA PRODUCTS CORPORATION
MICHIGAN CITY, INDIANA
It is doubtful whether there have ever been made such diligent searches for economies of operation as those now being conducted by the manufacturers of steel. Plant equipment and personnel are being closely scrutinized in order to detect any weaknesses which can be strengthened at an expense that will be justified by the savings obtained.

Producning units such as blast furnaces, open-hearth furnaces, and rolling mills are being made larger and are operated at greater speeds. In many plants steel melting furnaces are being equipped with automatic control mechanism in order to secure better and more uniform operation. Furnace refractories are receiving much attention, since the life of furnaces is in most instances dependent upon the endurance of the brickwork. Mill lubrication systems, until recent years given little consideration, are no longer neglected, but are being installed in many plants. Other features of steel mill operation that are productive of worthwhile savings are: the more efficient use of blast furnace and coke-oven gas; the more extensive employment of material handling equipment; an increasing appreciation of the value of welding for the repair and construction of machinery; and the cleaning and washing of coal, especially that used for the manufacture of coke.
Material handling in the steel and rolling mill calls for the application of equipment whose design and principle of operation are of such rugged nature and build as to withstand the imposing stress of rapid transfer.

From the handling of heavy bloom to the travel of light merchant stock, Birdsboro engineers have developed that which is most efficient in every type of mill table, furnace and billet pusher, cooling and hot bed, bundling and carrying device... in brief—a complete mill from start to finish.

The multiple type billet pusher and back-shear table (illustrated) form an interesting section of recently constructed mill equipment for a prominent steel manufacturer.
WHEN Leonidas Merritt discovered the Mesabi ore beds he presented the steel industry with the most formidable task in materials handling it has ever faced. To the accomplishment of that task our pioneer steelmakers responded with the same indomitable spirit that characterized all their undertakings. The task they faced was the moving of thousands of tons of ore from northern Minnesota to southern blast furnaces. Never has the steel industry been compelled to carry out a more costly undertaking than this; thousands of miles of railroad had to be laid; hundreds of ore boats built, and loading and unloading facilities revolutionized. On the success attending the efforts of the individual companies to secure the economical delivery of these ores depended their very existence. Some few companies in the Cornwall, Birmingham and Colorado fields have had problems of a different nature to solve.

After successfully accomplishing this task, our engineers were confronted with others of lesser importance, but nevertheless of considerable magnitude. Wellman’s machine has simplified the charging of open hearth furnaces; Hulett’s invention has reduced by many hours the unloading of ore boats; the McKee top has made more certain the proper filling of blast furnaces; and the crane magnet has greatly reduced the cost of transferring iron and steel. As the manufacture of steel has increased in this country material handling methods have become more complex; and, consequently, there has been demanded of our engineers expert knowledge of a high order in the use of devices that cause motion.

One has only to consider how expeditiously and economically millions of tons of iron and steel are handled in our steel plants to appreciate the value to the industry of our highly developed material handling practice. In the United States, especially, the ability to successfully meet competition is largely determined by the cost to transport raw materials and to move semi-finished products through the plant. The plea of steelmakers today is for speed, speed and more speed.
Steel plants should take advantage of the less-than-carload container service offered by the railroads. Many raw stocks received in the plant can be handled more efficiently, more economically and with less damage than by receiving them in carload lots and unloading by the use of wheelbarrows or other inefficient means.

THE less-than-carload container has for several years been a part of the service of railroads to their customers. Many concerns have taken advantage of the savings to be secured by shipping and receiving in such containers, yet most steel plants have not. It is the purpose of this article to describe the less-than-carload (L.C.L.) container and to attempt to point out its advantages as a means for receiving various commodities in steel plants.

Equipment

L.C.L. equipment consists of a standard low-side gondola car and steel containers which fit in it as shown in the accompanying illustrations. The car is usually at least 47 feet long by 9 ft. 3½ in. wide. Containers are of various dimensions, depending upon the kind of material to be shipped in them. Weight carrying capacity varies from 7000 to 12,000 lbs., according to type. Light weight varies from 2300 to 2850 lbs. Merchandise containers with drop sides usually number six to the car, while bottom drop types for brick, lime, etc., may be placed 10 or 12 to the car.

The L.C.L. container is provided, as may be noted in the illustrations, with eyes and proper supporting straps at the four corners by which it can be lifted from the car to a truck or other receiver by the use of a crane. It is fitted into place in the car by the use of guides and slots; thus all possibility of side sway or other change of location is avoided.

The method of handling the container is also shown in the illustrations. The ease of such unloading may be noted. It is of course necessary that the unloading point be equipped with a suitable crane and sufficient space to use it.

Advantages to the Steel Mill

Numerous raw stocks are received in the steel plant in box cars and unloaded by laborers with wheelbarrows. Other stocks are received in gondola cars and unloaded by crane and bucket at one central unloading point, later to be reshipped in small lots to the open hearth, finishing mills, or other points of usage. Still other stocks are received in sacks; these are easy to transport about the mill, but sack shipments cost more than those in bulk.

For example—every steel mill receives a great deal of fire clay cement and silica cement for use in the production of steel. These materials are received in gondola cars and unloaded at one central point and reshipped in small lots to various parts of the mill. The use of the L.C.L. container would allow these materials to be shipped directly to the point of use, thus eliminating the need for reshipping and saving time and labor.

A number of containers and gondola cars in the freight yard. The application of containers for shipping is rapidly spreading to all lines of industry.
Handling Problems

By W. C. KERNAHAN

An average of $3.00 per ton more is charged by the manufacturer for sack shipments of these commodities than for bulk shipments. Reception in bulk in the box car is very inefficient except in a few plants—the cost of unloading is high, and the material has to be transported to water-tight bins, later to be rehandled for conveyance to the point of usage. Neither should the cements be received in gondola cars—any moisture would damage them.

If these commodities were shipped in L.C.L. containers, the extra $3.00 per ton would be saved and unloading would be greatly facilitated. The car would merely be placed at the unloading point and the containers lifted off and emptied. As would be the case with box car unloading, it would be necessary to have constructed a bin to receive the material and to keep it dry. For easy conveyance about the plant it would be necessary to sack the material in the bin. However, the cost of sacking with the piece rate system is only about $.80 per ton, making a net saving of $2.20 per ton. If any quantities of the materials are received in the plant, the saving of $2.20 per ton would soon pay for the cost of a bin. Further, such a bin need not be much larger than a storage place for sack shipments. Some plants receive in bulk and unload by the use of clever devices, but not, I believe, as economically as by the utilization of container service.

Following is a list of some of the other stocks shipped into the steel plant for which L.C.L. containers could be used with attendant savings:

Firestone, mica schist, garnister, raw dolomite, foundry sand, barley coal, loam, limestone, magnesite, refractory clay, manganese and brick.

Such commodities are usually shipped in box or gondola cars and unloaded at a central point by the use of grab buckets or wheel barrows, and later reshipped in small lots to the points of usage as needed. The piece rate system is usually applied when grab buckets are employed for unloading—a small amount per thousand pounds. Were the materials shipped in containers, the piece rate per thousand lbs. could be reduced in the ratio of the amount one grab bucket holds to that which one container holds. Thus, if a bucket load of a commodity were 150 lb., and a container load 9,000 lbs., the piece rate for container unloading could be made 1/60 of that used for bucket unloading. The container of course takes longer to unload than the
Unloading lime from a bottom drop container into a truck

bucket; however, there is no cleaning up of the car to be done, which would very nearly equalize the difference between the rate at which the two could be unloaded.

Even greater savings could be shown were containers to replace box cars and wheel barrows. Unloading by the use of wheel barrows is undoubtedly very costly and inefficient.

Though brick is included in the above list as a stock which could be shipped in containers, such shipments would necessarily be small and would apply only to a small portion of this material received in the steel plant. Chances of breakage would be too great, though the saving in unloading expense might be found to more than pay for any damage.

A further saving which may be secured through the use of containers is the reduction in demurrage costs. Such costs often become a considerable item in the plant. Since the carload of containers could be quickly unloaded, there would be no excuse for demurrage charges on cars carrying raw stocks. With the slower methods often in use at present, unloading takes considerable time and only strict supervision by department heads can keep demurrage costs low.

Studies by operating officials or efficiency departments in individual plants would probably reveal many other commodities which could be shipped to advantage in containers. Each plant of course has its own particular conditions which would either permit or bar the use of such methods of receiving materials.

Advantages to the Shipper

Though advantages of the L.C.L. container to the shipper of raw stocks affects the steel plant only indirectly, it may be well to note some of them, which are as follows:

Savings in loading time and costs, savings in packing time and costs, expedition in service, elimination of loss and damage claims, the opportunity to ship and receive in smaller units which is responsive to present-day practices of maintaining inventories at a minimum, and savings in freight rates.

As stated above, loss and damage claims are eliminated. The container cannot be opened while it is on the car, and the steel construction prevents damage.

Loading is greatly facilitated. The container having been loaded at the shipper's place of business, it is locked by the shipper's own lock, trucked
to the railroad crane, and then lifted on the car, which transports it to its destination.

Why the Railroads Offer Container Service

The advantages to the railroad offering container service may also be noted as follows: Expedited service in effecting what amounts to store-door receipt and delivery, thus giving the railroad a possible solution to the problems of motor truck competition; its ability to cut down expense in handling less-than-carload traffic; its virtual elimination of loss and damage claims and the increased car loadings which have resulted from it.

The use of containers is spreading rapidly, and such a reception for the service seems to be well justified. Any effort expended in investigating its possibilities in the steel plant may show large returns in time and money.

Following is an excerpt from a statement made recently by the Interstate Commerce Commission:

"We have no difficulty in agreeing that the container as such is a commendable piece of equipment. Its savings to the carriers in loss and damage claims, in billing costs and platform expense, and the relief which it promises to existing terminals from actual or threatened congestion, all commend it. From what has just been said it should not be inferred that up to the present time carriers operating container service have, in fact, made any substantial profit from the service. We think, however, because of the merit inherent in the container itself, and the transportation economies which eventually can be developed with the more extensive use of the container, that the use of the container may well be encouraged."

Takes Exception to Author

Dear Mr. Editor:

I have read with interest the paper by Mr. William McConnachie on the "Importance of Cyanides in Iron Smelting," published in the July issue of Blast Furnace and Steel Plant. In this paper Mr. McConnachie refers to some work carried on by the Bureau of Mines and reported in Technical Paper No. 390—"Occurrence, Distribution and Significance of Alkalin Cyanides in the Iron Blast Furnace." Mr. McConnachie refers to table 12, page 21, of the above technical paper, which reports some supplementary samples taken at the slag notch of a Southern furnace. One sample shown indicates the presence of 588 ounces of cyanide per 1000 cu. ft. of gas. The cyanide is calculated as KCN.

I would like to point out that other samples taken at the same point under the same conditions ranged from .99 oz. to 56 oz. of cyanide as KCN per 1000 cu. ft. of gas. The wide variation in the samples taken at the cinder notch is due to the presence of accumulated cyanides at and around the notch. The samples are by no means representative of the quantities present in the cross-section of the furnace at the cinder notch level. On account of the accumulated slag and iron in the hearth of the furnace, it was not found practical to make a systematic survey from the inwall to the center of the hearth at the cinder notch level. The particular samples referred to by Mr. McConnachie are not therefore, representative of the conditions in the lower portion of the hearth level.

When this investigation was made these particular samples were regarded as accumulations which were not representative or comparable with the quantity of gas flowing. Accumulations of like nature occur at various points in the hearth and bosh of the blast furnace. These accumulations are due to condensation in colder sections of the wall. This condition is found not only in the hearth section but also in the tuyere and bosh sections and at points 20 feet above the hearth level. The samples collected in the wall where condensation has taken place are not representative of those found when the hearth or bosh of the furnace is surveyed from the inwall to the center of the furnace. Due to these findings, I cannot but feel that Mr. McConnachie has overestimated the quantities of cyanides present in the hearth section of the furnace.

The results of sampling across the tuyere level and at several points above the tuyere level indicate the presence of only small quantities of cyanides. The results were found to be consistent and the cyanide content of the gas was of the order of 3 to 4 ounces per 1000 cu. ft.

(Continued on page 1102)
OUTLINING an IRON and STEEL PROJECT

A study of the quantities of major materials to be distributed and the methods by which they are to be handled

By J. R. MILLER

PART II

In order to plan the equipment of the plant as well as to arrange suitable handling methods for the materials involved in operations, it becomes necessary to estimate the quantities of the different materials that will likely be required. First of all, the flow of the metals from the pig iron to the finished products must be outlined. For the capacity of the blast furnaces will depend on the capacity of the different plant units and the extent of the mining and other operations in connection with the raw materials.

Table III gives a rough outline of the metals and their flow throughout the different operations.

Table III

<table>
<thead>
<tr>
<th>Tons per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig iron, total quantity to be produced</td>
</tr>
<tr>
<td>Pig iron to steel plant</td>
</tr>
<tr>
<td>Pig iron to sales, to foundries and to molds</td>
</tr>
<tr>
<td>Pig iron to Bessemer department</td>
</tr>
<tr>
<td>Ferro-alloys to Bessemer department</td>
</tr>
<tr>
<td>Mold scrap to open-hearth</td>
</tr>
<tr>
<td>Mill scrap to open-hearth (more or less)</td>
</tr>
<tr>
<td>Pit scrap to open-hearth</td>
</tr>
<tr>
<td>Ferro-alloys to open-hearth</td>
</tr>
<tr>
<td>Ore to open-hearth, 231,000 tons at 55.6 per cent Fe</td>
</tr>
<tr>
<td>Pit scrap from open-hearth—4 per cent</td>
</tr>
<tr>
<td>Pit scrap from Bessemer—2 per cent</td>
</tr>
<tr>
<td>Ingots from open-hearth—88 per cent</td>
</tr>
<tr>
<td>Ingots from Bessemer—90 per cent</td>
</tr>
<tr>
<td>Total ingots</td>
</tr>
</tbody>
</table>

When the distribution of ingots to the various classes of finished products was made, there was kept in mind the great demand for railway rails that exists in the reconstruction of the railway lines and the necessity for large and small structural shapes for bridge and building construction (see Table IV). The distribution of the sizes and shapes of bars and rods is at present indeterminate, for until the demands actually develop to absorb smaller sections, no estimate can be made covering the detail of the mill schedules.

Table IV

<table>
<thead>
<tr>
<th>Tons per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingots to rails (all open-hearth steel)</td>
</tr>
<tr>
<td>Rails made—70 per cent</td>
</tr>
<tr>
<td>Scrap made—14.1 per cent</td>
</tr>
<tr>
<td>Discard billets to mills—7.4 per cent</td>
</tr>
<tr>
<td>Mill scale made—0.9 per cent</td>
</tr>
<tr>
<td>Loss—1.6 per cent</td>
</tr>
<tr>
<td>Ingots to billets and blooms</td>
</tr>
<tr>
<td>Billets and bloomed (excl. of discards)—86 per cent</td>
</tr>
<tr>
<td>Scrap made—11.5 per cent</td>
</tr>
<tr>
<td>Scale made—1 per cent</td>
</tr>
<tr>
<td>Loss—1.5 per cent</td>
</tr>
<tr>
<td>Ingots to large structural shapes</td>
</tr>
<tr>
<td>Large shapes from ingots—85 per cent</td>
</tr>
<tr>
<td>Scrap made—12.5 per cent</td>
</tr>
<tr>
<td>Mill scale made—0.9 per cent</td>
</tr>
<tr>
<td>Loss—1.6 per cent</td>
</tr>
</tbody>
</table>

Tentatively the billets and blooms to be rolled on merchant mills into small shapes and bars may be classified as follows, although the detail of the sizes and quantities will later be varied to suit the final schedules:

<table>
<thead>
<tr>
<th>Tons per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blooms, 8 x 8, 8 1/6 x 6 1/4, 8 1/4 x 5—</td>
</tr>
<tr>
<td>Blooming mills</td>
</tr>
<tr>
<td>Discards, 6 x 6, 5 x 5—</td>
</tr>
<tr>
<td>Large Billets, 6 x 6, 6 1/2 x 4 3/4, 5 x 5, 4 x 4—</td>
</tr>
<tr>
<td>Blooming mill and 24-in, billet mill</td>
</tr>
<tr>
<td>Small Billets, 3 1/2, 3, 2 7/8, 1 1/2 square—</td>
</tr>
<tr>
<td>Blooming mill, 24 and 18-in. billet mill</td>
</tr>
<tr>
<td>Total, all mills</td>
</tr>
</tbody>
</table>

The yield of blooms from ingots is calculated at 89 1/4 per cent, that of large billets 86 1/6 per cent, and that of small billets 85 1/6 per cent; the average for all is 86 per cent based on these proportions. These billets and blooms are to be considered as distributed among nine merchant mills as shown in Table V.
From these nine mills it has been estimated that there would be produced besides the above about 145,000 tons of scrap, and mill scale amounting to 11,000 tons yearly.

As to the distribution of open-hearth and Bessemer, there will probably be a change in Russia from Bessemer to open-hearth for railway rails. This is in line with the tendency of the Russian railways to adopt American standards.

Other products of the mills will, if Bessemer is made at all, be more or less in accord with the author's outline of grades published in the October, 1930, issue of Blast Furnace and Steel Plant. The adoption of Bessemer grades for various purposes will be contingent upon the final analysis of the ores and coke and upon their bearing on steel quality.

**Non-Metallic Materials Necessary**

By reviewing the above figures it is possible to plan the steel making, blooming, handling, and merchant mill equipment, to lay out suitable shops for the maintenance of the plant, and to provide plans for the general accessory plant equipment. However, there are other important materials beside the metals, the quantities of which must be decided upon. In doing this we will again use the blast furnaces as a starting point for all calculations.

In planning for the normal operation of the open-hearth and Bessemer as has been outlined in the metal flow, there will be required yearly 1,499,235 tons of Bessemer iron, and 1,000,765 tons of basic iron. The ore necessary for these quantities of pig iron may be listed as follows

<table>
<thead>
<tr>
<th>Iron ores for basic iron</th>
<th>1,531,420</th>
<th>Iron ores for Bessemer iron</th>
<th>2,287,593</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total local ores for pig iron</td>
<td>3,819,013</td>
<td>Total local ores for the open-hearth</td>
<td>231,000</td>
</tr>
<tr>
<td>Total local ores, all purposes</td>
<td>4,050,013</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These figures for the ores are based upon the theoretical burden sheets heretofore discussed and are therefore subject to revision, at least to the extent of including the amount of the acids added to the theoretical burden. Thus it will be necessary to provide for a liberal supply of concentrate to the blast furnaces.

Following is the amount of limestone necessary for metallurgical purposes:

| Limestone for basic iron | 222,070 |
| Limestone for Bessemer iron | 525,647 |
| Total limestone for blast furnaces | 747,717 |
| Limestone for the open-hearth | 160,000 |
| Total limestone, metallurgical | 907,717 |

These figures are also based on the theoretical burden sheets and are therefore subject to certain revisions, particularly as the basic open-hearth slag used in the burden calculation may not be represented in practice. Limestone is also required in the by-product plant, for building purposes, etc., which makes a larger quantity necessary.

| Coke for basic iron at .839 tons per ton iron | 840,000 |
| Coke for Bessemer iron at .863 tons | 1,294,500 |
| Total metallurgical coke | 2,134,500 |
| Coal required for this amount at 0.644 | 3,315,000 |

These figures for the coke requirement are arbitrarily set, and it is not to be assumed that the operation of this plant will be such as to compare with the best practice at all times; thus it will be advisable to allow leeway in the arrangements for supplying coke. The figure heretofore quoted for the coal has been 3,500,000 tons yearly.

Dolomite will amount to 57,400 tons per year in the raw state, and this must be burned as well as quarried and hauled.

In accordance with the general plan the plant haulage system will be built and equipped in Ameri-
can fashion as nearly as possible and will conform to the necessary local conditions. The cars and locomotives are planned to be of the most improved types now in use in the United States for the same purposes. The list of locomotives and cars are given in Tables VI and VII:

Definite savings of a considerable amount were estimated for the oil-electric locomotives as compared to the steam locomotives. However, the electric locomotives seem to offer the most economical operation for mining operations where overhead collectors do not have the same disadvantages in interference that are found in plant service. The oil-electric locomotives of course do away with this disadvantage, but the installation cost is considerably higher than that of either the steam or the electric locomotives. Even though the cost of the collector copper with the latter be included.

The cars will be for the most part of the regular American type and of standard capacity for the work they are to do.

Other Material Handling Equipment

In addition to the rolling stock listed, the plant railroad is to have available for loading and unloading materials, for construction work and for miscellaneous purposes, the following cranes and other equipment:

| 1—125 ton heavy wrecking crane |
| 5— 40 ton locomotive cranes    |
| 1— 50 ton locomotive crane    |
| 7— 20 ton locomotive cranes   |

These cranes will be supplied with special boom extensions for construction and rigging work and will be equipped to handle magnets and grab buckets. Other railroad equipment is as follows:

| 2—Jordon levelers                      |
| 1—Norburg track shifter               |

These are for use in grading and in track repair.

Eleven trains of five cars each will be required to serve the mining of the scattered ores. Each train will be kept intact with its locomotive always attached and serving the train continuously whether enroute, loading at the benches or unloading at the crushers. These trains will haul all of the scattered ores in 150 days of the year, making five trips daily. Fourteen trains, making 5½ trips daily, will operate in the same manner for 320 days of the year, and will haul the massive ores.

The scattered ores will be mined at the rate of 2,500,000 tons yearly, and the massive ores at the rate of 7,500,000 tons yearly, making a total of 10,000,000 tons, which at a total net yield of 55 per cent will provide 5,500,000 tons of concentrate. Of this at least 4,050,000 will be reduced at the local works, and the balance shipped eastward.

Handling of Ore in the Plant

From the cars the ore is dumped into bins over the crushers, and after concentration the product is delivered to high bins by conveyor systems whence it is drawn into the center dump ore hoppers for the haul to the blast furnace stock bins.

This movement of ore to the blast furnaces takes place every day in the year and is regulated to suit the exact needs of the operations. As there is little storage space for ore at the furnaces the tracks and rolling stock must be kept in the best of condition as the blast furnaces must be continuously supplied.

The haul is planned to employ trains of ten ore hopper cars, there being eight such trains always in service. The haul to the open-hearth will require ten more cars, and 30 cars have been allotted as spares. More may be required when the plant is under full operating conditions.

A considerable amount of rock waste from the concentration plant will be hauled out on the railroad to dumping locations. For this service 24 side dump cars are to be provided and two oil-electric or three steam locomotives. Electric locomotives will not be adaptable as the collector system over this variable trackage will be difficult to arrange.

Limestone is to be quarried at a distance of some 12 miles from the plant site. The type of cars used will be the same as those for the ore haul because center dump hoppers are adaptable to the stock bin arrangement. However, they will hold only 45 tons of limestone. As there is a grade each way in the track to the quarries the trains are made up of only seven cars. Ten trains are contemplated to be

<table>
<thead>
<tr>
<th>Location of Service</th>
<th>Two Alternate Plans</th>
<th>Electric and Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore from the mines to the crushers</td>
<td>25— 60 ton electric</td>
<td>25— 60 ton electric</td>
</tr>
<tr>
<td>Ore, boosters on grades</td>
<td>2— 60 ton electric</td>
<td>2— 60 ton electric</td>
</tr>
<tr>
<td>Concentrate to the blast furnaces</td>
<td>2—600 hp. oil-electric</td>
<td>2—107 ton 0-8-0 steam</td>
</tr>
<tr>
<td>Rock waste to dump locations</td>
<td>2—300 hp. oil-electric</td>
<td>3— 82 ton 0-6-0 steam</td>
</tr>
<tr>
<td>Limestone from quarry to plant</td>
<td>1—600 hp. oil-electric</td>
<td>2—107 ton 0-8-0 steam</td>
</tr>
<tr>
<td>Limestone quarry switching</td>
<td>1—300 hp. oil-electric</td>
<td>1— 82 ton 0-6-0 steam</td>
</tr>
<tr>
<td>Coal from railroad to coke plant</td>
<td>1—600 hp. oil-electric</td>
<td>2— 82 ton 0-6-0 steam</td>
</tr>
<tr>
<td>Blast furnace slag to dump</td>
<td>2—600 hp. oil-electric</td>
<td>3—107 ton 0-8-0 steam</td>
</tr>
<tr>
<td>Hot metal from blast furnaces</td>
<td>2—600 hp. oil-electric</td>
<td>2—107 ton 0-8-0 steam</td>
</tr>
<tr>
<td>Ingots, all haulage</td>
<td>2—300 hp. oil-electric</td>
<td>7— 38 ton 0-4-0 steam</td>
</tr>
<tr>
<td>Open-hearth charging</td>
<td>5—300 hp. oil-electric</td>
<td>8— 82 ton 0-6-0 steam</td>
</tr>
<tr>
<td>Miscellaneous switching</td>
<td>4— 60 ton electric</td>
<td>4— 107 ton 0-8-0 steam</td>
</tr>
<tr>
<td>Extra locomotives</td>
<td>2—600 hp. oil-electric</td>
<td>4—107 ton 0-8-0 steam</td>
</tr>
<tr>
<td></td>
<td>2—300 hp. oil-electric</td>
<td>7— 82 ton 0-6-0 steam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3— 38 ton 0-4-0 steam</td>
</tr>
</tbody>
</table>
at all times in service as unloading is not expected to be done quickly. The quantity handled will be in excess of a million tons a year.

**Handling of Coal and Slag**

Coal coming from Kuznezk will be received in 50-ton capacity cars of the usual type and in winter will go to the thaw house. When in condition to be unloaded it will be dumped by a car dumper into bins at the crusher in the coke plant. There is a storage space for coal under a traveling bridge crane. This is very necessary to provide for interferences with the flow of traffic over the Trans-Siberian railway. The shifting of the coal and cars will be handled either by one oil-electric or by two steam locomotives. The number of cars and the railway problems involved were discussed elsewhere in these articles.

Blast furnace slag disposal involves a heavy haul and certain definite problems. The dumping of the slag requires the continuous service of a locomotive, and the large amount of switching necessitated by the frequent flushing of the furnaces calls for ample motive power. As the blast furnaces are rated at 1000 tons daily capacity and will likely be run to 1200 to 1500 tons the slag haul will be very heavy. Three of the heaviest steam locomotives, or two of the largest oil-electric locomotives are recommended, and it may be that one additional locomotive will be required when the furnaces are placed in full operation. Slag amounting to 1050 lbs. per ton of iron will be in a year's time about 1,250,000 tons. The slag pots are designed to hold at least 300 cu. ft. or 13 tons of slag; however, the movements will not permit of filling the pots to capacity. With seven blast furnaces in operation there will be as many as 24 pots and cars enroute or dumping, five at the furnace casting, five at the furnace ready to cast, two at the furnace just finished casting, and three at each furnace, or a total of 48 slag pots and cars in service. The delivery of the slag from a furnace will be as follows, first flush—one pot, second flush—two pots, third flush—two pots, and while casting about three pots, making eight pots in all.

**Transfer of Hot Metal and Ingots**

Hot metal is also a heavy haul and requires heavy locomotives in spite of the fact that the route is level, as there are likely to be spills and other track difficulties. Also on account of the absolute necessity for serving a furnace promptly there must be a sufficient number of locomotives provided. The distribution of the ladles and ladle cars is about as follows: at each of the five furnaces not ready to cast one ladle is required, at each of the two furnaces casting or about to cast four ladles will be required, at the Bessemer mixer house three ladles, at the open-hearth mixer house three ladles and enroute six ladles, making a total of 25 ladles and ladle cars in constant service under conditions of full operation.

The movement of ingots at the open hearth and Bessemer as well as the transfer of slag to the breaking yard is accomplished by small locomotives all of the same size and type and usually interchangeable from one to another point of service. The ingot size was first set at around four tons and changeable from one to another point of service.

- Locomotives for this service are recommended to
be either 300 hp. oil-electric or 38-ton 0-4-0 steam. The locomotives for the ingot haul should be as-

Table VIII

<table>
<thead>
<tr>
<th>At strippers</th>
<th>Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-hearth—one heat</td>
<td>10</td>
</tr>
<tr>
<td>Bessemer—four heats</td>
<td>24</td>
</tr>
<tr>
<td>Empty buggies—10 for O. H., 6 for Bessemer</td>
<td>16</td>
</tr>
<tr>
<td>At soaking pits</td>
<td>16</td>
</tr>
<tr>
<td>In transit, Str. to soaking pits</td>
<td>16</td>
</tr>
<tr>
<td>At Bessemer</td>
<td>85</td>
</tr>
<tr>
<td>At open-hearth</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
</tr>
<tr>
<td>Extra for repairs and emergencies</td>
<td>33</td>
</tr>
<tr>
<td>Total ingot cars</td>
<td>275</td>
</tr>
</tbody>
</table>

signed to definite service as this is the most important job. The locomotives are distributed as follows:

| Locomotives | Steel haul at Bessemer (ingots and molds) | 1 |
|             | Steel haul at the open-hearth | 1 |
|             | Steel haul at Bessemer stripper | 1 |
|             | Steel haul at O. H. stripper | 1 |
|             | Mold yard Bessemer, molds to pour | 1 |
|             | Bessemer slag and bottoms | 1 |
|             | O. H. molds and slag | 1 |
| Total | 7 |

These locomotives are the same as those recommended for the open-hearth charging haulage and are interchangeable with them.

The open-hearth slag is to be taken out in slag thimbles of the same size and design as those for blast furnace slag, however, it is not found to be successful to use steel castings for slag containers in the steel works and cast iron is not at all durable unless reinforced; so these thimbles will be cast iron with steel bands. They will be hauled in and out on the same type of cars as those at the blast furnaces. The thimbles will be lifted off and set on stands at the open-hearth furnace where the slag spout discharges.

The billets and blooms that are transferred to the merchant mills from the blooming and billet mills were originally contemplated as loaded out of the billet yards in special type gondola cars with insulated tops, each having a capacity of 70 tons. Fifty of these cars were arranged in order to accommodate the usual slow handling of billets.

The charging of the open-hearth furnaces will involve the hauling of the entire amount of the materials of the charges from the stock house, on low level, to the charging floor, on high level. The charge for one furnace will consist of the following:

<table>
<thead>
<tr>
<th>Boxes</th>
<th>Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrap</td>
<td>64</td>
</tr>
<tr>
<td>Limestone</td>
<td>14</td>
</tr>
<tr>
<td>Ore</td>
<td>14</td>
</tr>
<tr>
<td>Pig iron</td>
<td>4</td>
</tr>
<tr>
<td>Mold scrap</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
</tr>
</tbody>
</table>

When two furnaces are charging simultaneously there will be at most 50 cars on the charging floor. 25 cars ready loaded for the next furnace, 36 being loaded with scrap and 14 being loaded with limestone and ore; this shows 125 cars in active service, which with 15 cars allowed as spares indicates that a total of 140 cars with the complement of charging boxes will be required. If steam locomotives are contemplated the 38 ton 0-4-0 will do the work expeditiously, allowing three to provide for a booster on the up grade to the floor. If oil-electric locomotives are used two 300 hp. will accomplish the work.

The Bessemer slag is to be collected in rectangular boxes and these set upon flat cars or buggies. The Bessemer bottoms are made up and put upon jack cars which are equipped with a hydraulic lift to set up the bottom tight against the converter.

Open-hearth and Bessemer slags and mill scale to the amount of 300,925 tons yearly are hauled to the blast furnace stock bins in ore hoppers, as well as flue dust from the blast furnaces to the sintering plant which latter amounts to some seven car loads daily. Besides slag from the skull cracker goes to the dump in air operated side dumping cars. This will usually be a residue of six or seven car loads left after supplying the blast furnace demand, but at times there may be ten to fourteen cars to go out.

The miscellaneous materials of operation and maintenance, brick, clay, ashes, sand, rubbish, cold pig, mechanical parts, lumber, coke, coal, etc., etc., are provided for as indicated in the tabulations of cars and locomotives accompanying this description.

First Iron Mine at Magnitogorsk Begins Operations

On May 15, exactly on schedule, the first iron mine began operations at Magnet Mountain (Magnitogorsk) in the Urals. Work has already been started on 25 mines. It is estimated that the deposits exceed 300 million tons of high-grade ore, not including tens of millions of tons of ore of poorer quality. The iron content of the ore is generally over 60 per cent, and in some cases 70 per cent.

The loading of ore has already begun, and by the end of May 15,000 tons were expected to be loaded. The program for June calls for 60,000 tons, for July—120,000, August—180,000 and September—210,000 tons.

Steel Founders Announce Meeting Dates

The first fall meeting of the Steel Founders’ Society of America, Inc., will be held in Chicago on Thursday, September 17.

Other meetings scheduled include one to be held in New York on October 22, the day preceding the Fall Convention of the American Iron and Steel Institute slated for New York, October 23.
Notations on various patented equipment for

The Handling of High-Grade Sheet Steel

By EDWARD S. LAWRENCE

A GREAT deal of attention has been paid within the past few years to the various means of handling, conveying, and transporting of high-grade sheet steels, particularly those which require a more or less perfect surface finish.

In the columns of BLAST FURNACE AND STEEL PLANT several interesting and very practical articles on this subject have already appeared. For reference, I call attention to the February 1929 issue of BLAST FURNACE AND STEEL PLANT wherein an article entitled “Solving the Problem of Shipping Sheets” discussed the subject to quite some length and in detail. This particular article was written at a time when shipping carefully bundled lifts of sheets in open gondola cars was making a marked development in the shipment of sheet steels. Further, in the August 1930 issue of BLAST FURNACE AND STEEL PLANT appeared an article entitled “Devices for Conveying Steel Sheet,” written by Frank M. Fish. This article likewise discussed in detail some of the more or less pronounced methods of handling and conveying sheets.

The present article is primarily interested in setting forth some of the various means of conveying and handling sheet steel, which developments have been considered of sufficient importance to be conceived of as inventions through the United States Patent Office. In the specifications for these various handling devices, the inventors have set forth in operative detail their various inventions, but it will be only necessary to repeat herein their more or less general and basic essentials. Quite a number of these inventions have already found a market and have proven quite successful. Other inventions about to be described have been tried out and found to be mechanically defective. While it would appear that if the invention is not practically successful, it would be advisable to refrain from its discussion, it is the author's contention that these unsuccessful patents have certain basic features which, if properly applied, would make them successful. Therefore, in order to bring the basic points of development into this article and to the attention of those who are particularly interested in the handling of the subject material, it is believed advisable to discuss all these recently issued patents.
pack to break the bond between them for separation by hand. After the sheets have been separated, they are re-plied and the pile consisting of loose sheets is carried to the cold rolls. Diescher sets forth in the above mentioned patent that he provides means whereby the several operations of hammering the packs, separating the sheets, and conveying the separated sheets to the cold rolls are so closely connected that the time of handling is materially reduced and transportation is facilitated. Diescher, therefore, uses the apparatus as shown in Figs. 1 and 2. Thus, the extreme left-hand side of Fig. 2 shows where the packs are opened by the hammering process and as the sheets are separated, they are tipped up on edge and allowed to roll along by gravity in a more or less vertical position to a table immediately behind the cold rolls. At this point, the sheet is tipped down by an operator and pushed through the cold rolls.

Lentz, in patent No. 1,727,204, titled "Sheet Stacking Machine," shows an apparatus for automatically piling the sheets immediately following their cold rolling. This is set forth in Figs. 3 and 4, in which Fig. 3 shows an end elevation of the sheet stacking machine looking toward the cold rolls, while Fig. 4 shows a vertical cross section in operative combination with a sheet finishing mill and a delivery table. It is quite possible that Lentz could substitute a scrubbing machine or roller leveller for the cold roll in this particular invention. The idea of the Lentz invention, as set forth in Figs. 3 and 4, is directed to a method of automatically stacking sheets one directly upon the other without their sliding and shifting, and thus preventing any marring or scratching of their surfaces. It is pointed out that the stacking of sheets behind cold rolled scrubbers or levellers has already been done by hand, and this machine will eliminate this manual labor heretofore necessary. The piling apparatus consists of a series of V-grooved wheels disposed in a horizontal plane which is in line with the center line of the cold rolls as noted in Figure 4. These grooved wheels in turn are mounted on pedestals, one series of which is positioned on one side of the rolls while a corresponding series is set up on the opposite and parallel side.

Operation of "Sheet Stacking Machine"

In operation the sheet is fed from the feed table through the finishing rolls as shown in Figure 4. The end of the sheet issuing from the rolls passes through the idler guide wheels which are between the piling table proper and the cold rolls. The side edges of the sheet are immediately caught in the rotating V-grooves of the conveyor wheels which, having a greater peripheral velocity than that of the rolls, causes the sheet to be moved very quickly onto the piling mechanism as it clears the cold roll proper, and thus avoids an interference of the successive sheets. These grooved conveyor wheels convey the caught sheet in the direction of the arrow A shown in Figure 4. The outer end of the sheet impinges against the stop at the end of the table, causing an electrical circuit to be completed, which in turn draws outwardly the conveyor wheels, thus enabling the sheet to drop directly upon the pile. As the sheet drops, another circuit is completed, enabling the pedestals with their grooved wheels to spring back in a normal vertical
position ready to catch, convey, and automatically stack the next sheet being fed through the mill. When the pile has been completed, the pedestals can be swung out of position, enabling a crane to lower crane hooks around the pile and transport it to some other part of the plant.

Lentz also shows in his patent No. 1,739,319 another piling mechanism similar in many respects to the one above described. However, in this later patent, the sheets are conveyed onto a run-out table shown in Figure 5, which is a side elevation of this particular apparatus. Fig. 6 shows a transverse sectional view and illustrates the trip catch mechanism for the rotation and sliding of the stacking arms of the machine and illustrates in dotted lines the trip catch mechanism in various positions of rotation. This mechanism works on the principle that the sheets come through the rolls as illustrated and run out on the disc type conveyor table. The discs are rotated at a peripheral speed slightly faster than the peripheral speed of the rolls as in his other patent. The sheet travels on these discs until the end of the sheet contacts a stop. This contact with the stop sets in motion the stacking arms which come up underneath the sheet and swing it through approximately 120 degrees. As these arms swing upward and over, the sheets slide for a short distance down against them and in such a position that when the stacking arm is at about 120 degrees, the sheet is in a position to drop by gravity onto the stack of sheets shown. After the stacking arms rotate through approximately 120 degrees, they slide back to their original starting position and then are ready to pick up and swing over the sheets which follow in close succession.

The Evans Stacker

With further reference to sheet stackers, the Evans patent, No. 1,767,442, is of particular interest. A diagram of this patent (Fig. 7) shows the side elevation of the sheet stacking apparatus constructed in accordance with this invention. The main object of the invention is to provide an apparatus which will be automatically raised as the pile is formed. The invention relates more specifically to a cold roll packer for piling cold rolled sheets or plates, and is of such a type that it provides for the delivery of sheets with a minimum drop onto the pile. Thus, in Fig. 7 there is a cold rolling stand at the extreme right, which releases the sheets after rolling. They then pass on a belt to the stacking apparatus proper shown at the extreme left. Having reached the stacking apparatus, the sheets leave the belt and pass through feed-out rollers which are so shaped that they cause the sheets to be bent or flexed transversely and by this procedure stiffened sufficiently to make certain their discharge on a more or less horizontal plane. Passing out of the guides, the sheets strike a stop plate and fall by gravity onto the pile. The apparatus is so arranged that by a counterweight attachment a definite pile will cause a circuit to be completed, which in turn lifts the entire piling mechanism a predetermined distance. Thus, as the pile is accumulated, the stacking mechanism raises periodically through a predetermined distance and thus maintains a minimum drop from the sheet to the pile itself. While this apparatus is applicable to cold rolled sheets, it is particularly well adapted to the handling of tin plate and probably is intended for such.

Williams patent, No. 1,688,219, shows and describes a sheet piler which operates in many respects similar to the Lentz patent No. 1,727,209. Williams' object is to pile automatically full-finished sheets, without scratching or marring their surfaces, into piles having smooth and even sides which permit subsequent box annealing without the danger of burning the ends of projecting sheets during the annealing process, which condition is always present when the sheets are unevenly piled.

A further object of the invention is to provide a machine adapted to placing adjacent to the delivery side of the rolls of a rolling mill or other apparatus in a position to receive the sheets as they are successively delivered therefrom and while they are...
moving longitudinally, to afford vertical support thereto until the sheet reaches a predetermined position and is entirely clear of the delivering machine and to then suddenly and rapidly withdraw such support so as to allow the sheet to fall vertically either on a subjacent support or on the upper surface of the preceding sheet as it rests at the top of the pile of sheets being formed by the machine.

This is accomplished by a machine whose end cross-sectional view is shown in Figure 8. Heavy pedestals are mounted opposite to each other and are on rails which permit longitudinal movement of the piling mechanism. The pedestals themselves can be moved toward or away from each other, thus permitting adjustments for the various widths of sheet to be piled. Mounted on these pedestals are short rollers which overhang the top of the pedestals. These rollers thus receive and vertically support the edges of the sheet as it comes to the piler from the hot or cold rolls. The sheets then are moved one at a time progressively toward the end of the piler between the pedestals and upon the rollers which engage beneath its lateral edges. Having reached a predetermined distance wherein the sheet has cleared the hot or cold rolls and is ready to be piled, the foremost end of the sheets engages a stop which in turn completes a circuit and causes the top rails on the pedestals to pull away and in opposite directions to each other, thus causing the rollers to be withdrawn from under the sheet. The sheet then drops onto the pile and is guided on the ends and sides so as to cause the formation of a square-edged pile as one sheet follows another.

Another patented device for handling highly finished sheet metal is disclosed in the Donnelly patent No. 1,761,881 as shown in Fig. 9. This device relates to an automatic sheet stacker where uppermost sheets of a pile are to be moved from one stack to another, or from a pile to a rolling mill, or vice versa. This is brought about by providing a set of vacuum cup sheet gripping members adapted upon engagement with the sheet for lifting and moving it. Means for automatically releasing the sheet from the gripper vacuum cups is also provided. Thus Fig. 9 shows the side elevation of the invention in assembled position. The vacuum cups are hung from a horizontal beam, which is, in turn, attached to a vertical beam which rotates as well as lifts the horizontal beam with its cups through predetermined distances. It will be noted that the cups are fastened to a central rod and each rod has two side cables. The action of suction and release of the cup to the sheet is brought about by first bringing the cup into contact with the material and flattening the same onto the sheet by pushing the cup down with the center rod. The cables, in turn, have rocker arms which hold or release the cup from its flat position. Thus, with the cups flat and the cable and rocker arms released, the horizontal arm starts to lift and the cups return to normal position, causing a vacuum to be created which in turn lifts the sheets. The vertical arm (lifting the sheet in a horizontal position) swings around and automatically lowers the sheet to the position desired. As the sheet is lowered into the desired position, the center rods push the cups flat and automatically the rocker arms hold the cup at this shape. Thus, the center rod lifts and the cup lifts free of the sheet with no vacuum created and the apparatus swings back to the other piling (or unpiling) position ready to repeat the cycle of operation.

(To be continued)
Equipment and Methods for

The Economical Handling of Scrap

As is generally known, the cheaper kinds of scrap—stampings, turnings, etc., are bulky, difficult to handle and require more time to charge into the furnaces than the better classes of scrap. When charging light iron scrap, turnings, etc., the boxes are not filled to their full capacity, and therefore a more frequent opening of the furnace-doors is needed, causing a comparatively great loss of heat. These drawbacks can be done away with by the installation of a hydraulic bundling press of sufficient capacity. Good results are being obtained in this direction and Messrs. Lindemann & Schnitzler, Engineers, Dusseldorf (Germany), are specializing in this class of machinery.

Fig. 1 shows a large triple acting press, with a capacity of about 7 1/2 tons per hour, the bundles measuring 16 in. by 24 in. by about 48 in. A number of presses of this kind are in use in Continental steel works, and a similar press of a slightly smaller type, having an average production of 5 tons per hour, is installed in an important English steel work. These machines are very strong, all steel, the insides of the large box being covered with interchangeable steel plates of special alloy steel.

The horizontal construction of this press and its large press box—being 8 ft. long, 6 1/2 ft. wide and 2 ft. 8 in. deep—is particularly advantageous, as it facilitates loading considerably. Besides this, a feeding hopper is provided, which is always ready to be filled with scrap by magnets or cranes and which is lifted and lowered by hydraulic power, and operated by the man in charge of the machine. This hopper, at the same time, ensures an even distribution and portioning of the scrap inside of the box. To lift or to lower the hopper, the operator has only to draw a special lever, which is within easy reach of the main valve station. The main valve, by which the pressure water is guided into the different cylinders of the press, is operated by a hand wheel, which is simply turned round in one direction, in order to make the press execute the various motions, a special indicator showing exactly the position of the press rams at a glance. This indicator is in front of the operator.

Operation of the Horizontal Press

It is very essential that bundling presses be capable of giving a large output with the least possible amount of labor. For this reason, we think, we must explain a bit more fully hereafter the operation of an up-to-date bundling press, referring at the same time to Figs. 2, 3, 4 and 5. Only one man is needed to operate the complete plant, and this, as said before, is a most important fact.

Fig. 3 shows the box filled and the hydraulically operated lid ready to go down and exert the first compression; the pile of scrap, projecting at the upper edge of the box is forced down by the lid, which enters the press box about 8 in. (see Fig. 4).

This feature allows the charging of even the most bulky pieces of scrap (old barrels, bedsteads). Such parts of scrap which might get between the edges are sheared off, as the edges of the box and lid are sharpened. As soon as the lid is down, the horizontal half-pressure rams with their press plate are executing the next compression by moving forward inside of the box (see Fig. 5), the pressure being so intense that almost any resistance offered by very hard pieces of scrap is overcome easily. After this compression, the high-pressure ram with its press plate finishes the bundle (see Fig. 6) and is cut off automatically as soon as the maximum pressure of the pump, 4267 lbs. per sq. in. is reached.

Each bundle therefore is subject to the same amount of pressure, and this explains why the third dimension of the bundle is variable according to the quality and quantity of scrap filled into the box. The compression from three sides not only increases the density of the bundle, but makes it sufficiently compact to withstand any kind of rough handling without falling to pieces and without requiring any wiring.

As soon as the high-pressure ram has finished the bundle, a door on one of the long sides of the press...
box is opened and allows the bundle to be ejected automatically. This arrangement facilitates remarkably the conveying of the finished bundle to the furnaces, as it can be pushed directly into the box or onto the peel. One man, operating the machine by the central valve-station, can watch the finished bundle clearing the box and at this moment can send back all rams by one turn of the wheel, so that in but a few seconds' time the box is ready to receive the next charge.

The operator has furthermore at his disposal a special emergency-brake, enabling him to stop the machine immediately in case of need.

**Hydraulic Accessories**

The pressure water required by the press is delivered by a multi-stage hydraulic pressure pump, which is especially designed for use in connection with the hydraulic bundling press. In this pump, the pressure is controlled so that the press can start with a very fast motion and reduce its speed automatically and flexibly with the increasing density of the bundle. When the highest pressure of the pump is attained, it is cut off automatically, so that the machine may be considered fool-proof. This particular construction of the pump possesses the advantage that the least possible amount of electric power is consumed. The water used in the pump circulates within a closed system in the plant, that is, as soon as the pressure water is released, it returns into the pump tank, passing before through a special filtering tank, so that loss of water is avoided and any addition to the water—greasing substances or glycerine—is saved.

In cold weather, a certain portion of glycerine is added to the water or a suitable substitute, thus preventing the water from freezing. In view of the above mentioned circulation of the pressure water, the costs of the glycerine or other substitute are insignificant.

The hydraulic pump is driven by an electric motor with tension pulley and belting; the consumption of power is low, as explained above. The chief advantages of the triple acting bundling press—as compared with bundling presses of previous or ancient construction—are the following:

1. Spacious feeding hopper, which works intermittently.
2. Large press box with a large opening.
3. Strong compression by the lid.
4. Edges of press box and lid act as shears.
5. Triple compression, producing dense bundles.
6. Automatic ejection of bundles directly on peels or into boxes.
7. Central distribution-valve station, operated by one man only.
8. Sufficient devices to make the plant fool-proof.
9. Best possible efficiency as compared with electric presses—no gears required.
10. Small consumption of power, therefore low costs.

It may be of interest to note some details of the results which have actually been obtained in practical use with such triple acting presses, which are capable of bundling light iron scrap up to about 1/6 in. thickness as well as turnings. The quantity of turnings which can be added to each bundle is dependent on the quality of the turnings. Long, stringy or curly turnings can be bundled without the addition of other scrap. Short steel turnings, however, can only be bundled if mixed with light iron scrap. In this way, up to 50 to 60 per cent of short steel turnings can be added to the bundles. Table I gives some practical results.

It must be considered as an additional advantage of the machine that long, curly, as well as short steel turnings, are bundled into a handy shape, thus rendering their use for the furnaces more econom-
Table I—Results with “Cilan” Press

<table>
<thead>
<tr>
<th>Kind of scrap</th>
<th>Weight of bundle</th>
<th>Size of bundle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light iron scrap</td>
<td>1260 lbs.</td>
<td>16 by 24 by 58 in.</td>
</tr>
<tr>
<td>Stampings</td>
<td>1560 lbs.</td>
<td>16 by 24 by 52 in.</td>
</tr>
<tr>
<td>Wire scrap</td>
<td>1120 lbs.</td>
<td>16 by 24 by 50 in.</td>
</tr>
<tr>
<td>Long, curly, mild steel</td>
<td>1290 lbs.</td>
<td>15 by 24 by 59 in.</td>
</tr>
<tr>
<td>turnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short, hard steel turnings</td>
<td>1360 lbs.</td>
<td>16 by 24 by 62 in.</td>
</tr>
<tr>
<td>mixed with light iron scrap</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Another point which should not be forgotten is the reduction in the costs of labor, as the press operator can push the bundle directly onto the peel or into the box.

The “Rasso” Press

A well-known German steel work installed early last year a Lindemann scrap block press Type “Rasso,” which offers the maximum of benefit, as the blocks made by this machine are of a density most economical.

This press is of the horizontal type and is also fitted with a feeding hopper, which empties its contents in a spacious press box 7 ft. 4 in. by 6 ft. 8 in., depth 24 in. By closing the press lid and by the penetration of the horizontal rams from two sides

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Fig. 5—(Top) Showing the reduction of the scrap by the hydraulic half-pressure ram or rams working horizontally. This is the second compressing operation. Fig. 6 (Bottom) The reduction of the bundle by the high pressure ram. This is the third compressing operation. The bundle is then ejected automatically.

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Table II

<table>
<thead>
<tr>
<th>Kind of scrap</th>
<th>Weight of block</th>
<th>Length of block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light iron scrap</td>
<td>ab. 520 lbs.</td>
<td>30 in.</td>
</tr>
<tr>
<td>Stampings</td>
<td>700 lbs.</td>
<td>32 in.</td>
</tr>
<tr>
<td>Light iron scrap mixed with</td>
<td>640 lbs.</td>
<td>32 in.</td>
</tr>
<tr>
<td>steel turnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed long and short turnings</td>
<td>750 lbs.</td>
<td>34 in.</td>
</tr>
</tbody>
</table>

The feeding of this block press is done by two multi-stage hydraulic pressure pumps, driven by an electric motor with belting and tension pulley. Special safety devices protect press and pump against overcharge and cut off the pumps automatically when the highest pressure is attained.

Thorough and extensive studies and experiments have proved that blocks of the most economical density offer very appreciable advantages. These blocks, made of cheap material, are equal in quality to heavy melting scrap, so that it can be done away with, therefore reducing the costs of scrap considerably. If carburizing material is added to the scrap, when filled into the box, it gets into the block, so that they will be equal in quality to pig iron. Although the addition of carburizing material is
known—generally coal briquets are added—it should be considered as a step forward that by the use of the block press a much more even distribution of the carbon is attained.

As each big block is composed of eight small blocks, these are distributed evenly inside of the furnaces and offer sufficient surface to be attacked by the heat.

Very interesting tests have been made to reheat and roll these blocks directly, without having them remelted in the open hearth furnaces. Important German steel works, as for instance "Klockner-Werke A. G., Apt.: Georgs Marien-Werke, Georgsmarienhütte," have joined in these experiments, which have given favorable results, and we are informed that in one of these works the blocks have even been rolled into tin plates of 1/32 in. The blocks shown in Fig. 2 had been made specially for these tests, that is, to roll into iron bars and plates.

Block No. 1, weighing 366 lbs., consists of tin plate scrap exclusively (new trimmings). Block No. 2, weighing 570 lbs., consists of new trimmings and destructor scrap. Block No. 3, weighing 532 lbs., consists of destructor scrap exclusively.

Fig. 7 shows bars and tin plates (flat iron, iron rods, square iron), rolled out from the reheated blocks shown in Fig. 2.

The experiments made have proved that Block No. 1, consisting of new tin plate cuttings exclusively, welded perfectly in the reheating-furnace and was rolled out to iron bars of good quality. Blocks No. 2 and No. 3 did not weld completely on account of the low quality of scrap of which they were composed, and for this reason the iron bars rolled from these blocks did not give perfect results. The characteristics of the bars were as follows:

<table>
<thead>
<tr>
<th>Block No.</th>
<th>Tensile strength, kg.</th>
<th>Elongation, per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34.4</td>
<td>250</td>
</tr>
<tr>
<td>2</td>
<td>32.3</td>
<td>170</td>
</tr>
<tr>
<td>3</td>
<td>33.8</td>
<td>127</td>
</tr>
</tbody>
</table>

A separate test was made with a test bar forged by a steam-hammer and using part of Block No. 1 with the following result:

Tensile strength—36.6 kg., elongation—34.5 per cent.

The analysis of the rolled material showed the following figures:

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Si</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block No. 1</td>
<td>0.060</td>
<td>0.451</td>
<td>0.019</td>
<td>0.052</td>
<td>0.075</td>
</tr>
<tr>
<td>Block No. 2</td>
<td>0.040</td>
<td>0.396</td>
<td>0.028</td>
<td>0.036</td>
<td>0.019</td>
</tr>
<tr>
<td>Block No. 3</td>
<td>0.035</td>
<td>0.360</td>
<td>0.044</td>
<td>0.073</td>
<td>0.010</td>
</tr>
</tbody>
</table>

The metallographic certificate of the tests is the following:

(a) Macroscope: The test bar, which has been broken, showed a dull grey, having the structure of normal tough iron. Even the surface on the broken spot did not deviate from normal conditions.

(b) Microscopic: The microscopic composition of the test bar was identical with that of very soft iron. Although there were signs of oxidation, there was no alteration in the general good structure of the material. The crystalline cohesion could be considered good.

The fact must be emphasized that the above mentioned blocks were made from scrap which had been taken at random from the store yard and not selected especially for these purposes. However, the results obtained must be considered very promising.

Takes Exception to Author

(Continued from page 1089)

Mr. McConnachie indicates in his paper that the samples taken at a point 27 inches above the tuyere level did not contain greater quantities of cyanides because the samples were taken directly over the center line of the tuyere. It might be pointed out that samples at the inwall were taken at a point 27 inches above the center line of the tuyere, also, that the sampling was continued from the inwall to the center of the furnace. The results indicated the presence of approximately 3 oz. of cyanides per 1000 cu. ft. of gas at the center of the furnace. The cyanide in the gas gradually increased from the inwall to the center.

Recent investigations have shown that the flow of gases in the hearth and bosh of the iron blast furnace is not uniform. Greater quantities of gas are flowing in the hearth and bosh of the furnace near the inwall than are flowing, per unit of area, in the center of the furnace. The results of the investigation on the quantity of cyanides in the gas in the hearth and bosh sections of the furnace indicate the presence of greater quantities of cyanides in the gas in the center of the furnace than in the vicinity of the inwall. These two observations, when taken into consideration, would show that the presence of cyanides is considerably smaller in amount than is indicated in the investigation, due to the fact that the flow of gas in the center of the furnace is at a minimum and that the quantity of cyanides present is at its maximum.

Most investigators have based their determinations as to the quantity of cyanides in the hearth and bosh sections of the blast furnace mainly on the deficiency of nitrogen present in the gas in these sections of the furnace. It is my belief that this premise as a basis of calculation is entirely wrong, due to the fact that the deficiency of oxygen, with the increase and decrease of nitrogen, may be effected by the oxidation or reduction of iron oxides in the lower portion of the furnace. Calculations involving the quantities of cyanides present, based on the deficiency of nitrogen, do not as a rule check with the quantities of cyanides actually found in the gases determined by sampling.

Very truly yours,

S. P. Kinney.
Steam and Steel—Power
HAIR CRACKS on the SURFACE of SHEETS *

By ERICH A. MATEJKA
Dipl. Engr., Witkowitz

PART II

In a discussion of the results obtained in the main experiment to determine the cause of the defect, it would be well to take up the several studies in the order before given.

I. Production of the steel

1—The type of steel furnace. According to Meerbach, on using a Talbot furnace we must give up the possibility of working the heat in the hearth to complete deoxidation and separation of the manganese oxide which forms as an emulsion. In order to see whether the material produced in the Talbot furnace differs from that produced in the other furnaces, the heats tapped from the two types of furnaces were compared. We could not observe a noteworthy difference between the heats. Also, we could not show that the great depth of bath in the Talbot furnace might be a disadvantage to the quality of the steel. As regards the yield of sheets with good surfaces, we certainly can assume the superiority of the tilting furnaces, that is, of the Talbot and the Wellmann furnaces.

2—The charge. We shall give a description of each experiment that concerns the method of production. With the large number of different influences that act on the heat as it melts or on the quality of the final product, it was difficult to find a method that included all influences. For this reason, individual characteristic processes in production, which had been shown to be significant in regard to the quality of the material either on the basis of actual experience or of theoretical knowledge of the steel method, were isolated and, as far as possible, tested for their effect on the appearance of surface cracks.

(a) Pig iron. It is frequently stated in literature on the subject that the chemical composition of pig iron exerts an influence on the behavior of the steel made from it. Thus, B. Fletcher has assumed an effect exerted by the carbon content, and Kärner an effect exerted by the manganese content of pig iron. Now it has been established that the action of the steel on pouring influences the growth of the ingot structure. For this reason the heats with the same yield of good sheets were kept together and there was calculated the average chemical composition of the pig iron that was used in the production of heats of like composition. In addition, a differentiation of the pig iron by the appearance of the fracture of a test-piece was found to be suitable. We could not find any relation between the chemical composition of the different kinds of pig iron and the appearance of the defect.

(b) The amount of carbon and manganese. The effect of the carbon content of the charge on the later action of the steel during hot working was investigated in a manner similar to Kothny. We agreed with Kothny, in that no effect of the carbon content of the charge could be noticed.

The importance of a higher manganese content in the charge is generally well known. According to Dichmann manganese can be used to prevent the penetration of oxygen into the melt, so that rather large amounts are added to the charge. Starting from this assumption the carbon and manganese contents of the charge were studied, but we found no essential difference in the manganese content of good and bad heats. Therefore it probably can be assumed that the manganese content of the charge is high enough.

3—Finishing the heat. Making use of the results of the preliminary experiment, the effect of finishing the heats with or without roll scale or ore was also investigated in the main experiments. The purpose of the addition of ore or scale is taken up in great detail by Dichmann and from his statements it must be seen that the determination of the correct amount of these materials is of great importance. It is conceivable that an excess of ferrous oxide will permit this to enter the bath to an injurious extent. In the hearth furnace method, oxygen gets to the iron in rather large amounts since the free ferrous oxide in the slag dissolves in the liquid metal. It can be observed that iron takes up oxygen and that even large amounts of reducing agents cannot completely prevent it. Also, the resistance offered varies. Barba and Howe also found that at the end of the addition of ore, the steel is rich in oxygen in the form of ferrous oxide.

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*Translation from the Archiv fuer das Eisenhuettenwesen.
Address at the annual meeting of the Vereins deutscher Eisenhuettenleute.
(a) Finishing with or without roll scale. Contrary to the preliminary experiments, the main experiment showed that the addition of sinter during finishing has no effect on the appearance of the defect (Fig. 6). This contradiction between the two results is somewhat modified since the use of sinter had been restricted in the preliminary experiments. This is shown in Fig. 6. As compared to 346 heats finished without sinter, there were only 33 finished with it. Also, since the amount of scale added per heat was reduced, it is possible that this was the cause of avoiding a dangerous excess of ferrous oxide.

(b) Finishing with or without ore. The investigations on the effect of the ore during finishing were without result.

(c) Decrease in the carbon and manganese content. In order to be able to follow the process in its last stage and to investigate its relation to the quality of the steel, we determined the decrease in the carbon and manganese content of the bath during finishing. The shape of the curve of averages shows that there is no relation.

(d) Carburization in the furnace. Monden in his investigations found an improvement in the quality of the steel in two cases on carburization with solid carbon in the form of waste electrodes. In order to test whether the customary carburization in the furnace with spiegeleisen (about 4.5 per cent C) also might affect the quality of the steel under certain circumstances, the heats with different yields were tested for this. An improving influence could not be detected on carburization with spiegeleisen.

(e) Carburization in the ladle. According to Duhr, the addition of coke in the ladle increases the nitrogen content of the steel because of the nitrogen in the coke. Under certain conditions this might affect the action of the steel on pouring, and accordingly, the development of the structure of the ingot. On the basis of the results of the main test it must be assumed that carburization in the ladle, contrary to the result of the preliminary experiment, has no connection with the appearance of the defect.

4—The slags, their iron and manganese content. Because of the importance of the iron and manganese content of the slags, which is of striking importance for the interaction of bath and slag, it seemed fitting to study the amount of these in heats of different quality.

The ratio of Fe to Mn in the slag was watched because, according to Naske, it decides the reduction or oxidation of manganese. But Dichmann takes the opposite view, and assumes that it is not because of a particularly favorable ratio of manganese oxide to ferrous oxide, but that the true amount of these two oxides is determinative, so that this also was included in the investigation. Dichmann considers that equilibrium with ferrous oxide in the slag and the reducing agent in the iron in the basic furnace is reached when the amount of iron in the slag has dropped to 10 per cent Fe = 13 per cent FeO, so that in order to get a good final product it is desirable that the amount of manganese be just as high.

The large-scale test showed that in a general way the heats studied are in accord with the views developed above. No difference could be found between good and bad heats.

5—The manganese content of the heat before tapping. As an extension of the preliminary experiment, the effect of the manganese content of the heat before tapping also was observed in the main experiment.

Many references are found in technical literature on the relation between the manganese in the heat and the quality of the product. We shall mention only the conclusion Colelough draws from his work, which is of real importance in steel-making—the higher the manganese content of the heat before tapping, and the lower the amount of ferrous oxide dissolved in the heat, the quieter will be the metal on casting, and there will be fewer delays in

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Fig. 6—Effect of the addition of roll scale

Fig. 7—Effect of the manganese content of the bath
The result is also the same in the main experiment (Fig. 7). Heats with higher manganese content before tapping give a higher yield of sheets with sound surfaces. The curve is not such that one could make the effect of this material during production responsible for the appearance of the surface defect, but again we see from it the great importance of manganese in steel-making and its great effect on the hot workability of steel, as it increases its toughness and makes it possible to retain its cohesion at higher temperatures and at greater stress.

Accordingly, the results of the investigation merely confirm the known effect of the manganese content of the heat before tapping on the hot workability of the steel, but that this content, when exceeding a certain limit, should not be regarded as a cause of surface cracks is shown in Fig. 8.

6—Deoxidation. In spite of the most careful observation of all precautions that are intended to prevent an excess of oxides in the slag, we were not entirely successful in preventing oxygen from reaching the metal, and in almost every case the oxygen content was so high that at least a part of it must be removed. According to experience, this is best done by the addition of certain materials such as manganese, silicon or carbon.

Experience has also shown that the physical properties of over-refined iron are not good. It is red-short and cracks on forging and rolling.

Monden states that many defects in the finished steel, particularly lack of workability in the red-hot condition, can be traced to insufficient deoxidation, without supporting this reasoning by figures or test data. Eilender shows the harmful effect of incomplete deoxidation which is exerted on hot-working of the steel. Osann uses the law of mass action to explain why the deoxidation is not always complete, so that under certain conditions the last of the elements accompanying the iron must be removed. According to this law the balancing of the chemical equilibrium takes place quickly with high concentration, and slowly with low concentrations. In the latter case there may be so much inertia that it actually seems to be stationary. Eilender, agreeing with Oberhoffer, states that the success of deoxidation is influenced by the character and properties of the products of deoxidation, in addition to the degree of completeness of it. The slag will separate from the steel and rise to the surface according to its properties, its specific gravity, the agglomerating power and the melting temperature. The course of the conversion as well as the process of the separation of the slag depends to a great extent on the temperature of the heat.

The above considerations show the necessity for suitable investigations.

(a) The amount of ferromanganese additions. As manganese acts on the oxygen better than any other reducing agent, Dichmann states that the quality of the steel is not injured to any extent by the formation of manganese oxide during deoxidation, even if it is not given time to separate out and therefore remains in the metal in suspension. As stated, the action of the deoxidizing agent is not complete, just as is the case with ferromanganese. Consequently it must be used in excess. This excess increases the manganese content of the heat. Therefore the completeness of the deoxidation depends on the amount of manganese added as well as on the other conditions that have been mentioned. In the description of the acid open hearth method (the same also holds for the basic method) Campbell states that if an addition of 1 per cent Mn to a metal bath gives it a manganese content of 0.6 per cent for example, then the manganese con-
sumption is 40 per cent, and an addition of only 0.5 per cent will give the bath only 0.4 per cent so that the manganese loss in this case is only 20 per cent. It seems that with the smaller manganese addition the action is not complete, and that with further additions of manganese more oxygen can be separated. This fact is always confirmed, no matter whether the manganese is added in the ladle or in the furnace.

The results of the investigations on the effect of the size of the ferro-manganese addition show that no great difference can be seen between the heats with different yields of sheets with sound surfaces.

(b) Deoxidation in the furnace and in the ladle. According to Dichmann deoxidation in the furnace has certain advantages over that in the ladle. Meerbach assumes that on using the Talbot method, in which only deoxidation in the ladle is considered, it is advantageous to let the heat teem in the furnace to complete such reaction. In order to test this opinion there was calculated the average yield of heats deoxidized in the furnace or in the ladle. Thus it was found that at least the method of deoxidation had no effect on the appearance of the surface defect.

7—Melting time. The relation between the melting time and yield was tested in the large experiment just as in the preliminary experiment. According to Dichmann there is a relation between quality of the steel and melting time since conditions are obviously best for the production of metal low in gas if the completion of gas formation takes place in the furnace, that is, if tapping is not done before equilibrium is reached between slag and metal. As a matter of fact, as this equilibrium is approached the reactions take place more slowly, and therefore we must sacrifice a certain time if the heat is to be completed under such conditions. Then, and only then, according to Dichmann, is it possible to produce metal that has the minimum amount of gas mechanically retained and the metal remains perfectly quiet even on solidification. Like the preliminary test, the main experiment also shows a slight rise in the yield curve for heats taking longer time. (See Fig. 9.)

8—Chemical composition and strength of the heats. As a supplement to the similar preliminary experiment which referred only to the average strengths of the heats of different quality, the average carbon, manganese, phosphorous and sulphur were determined in the large-scale experiment, but no relation to the defect was found.

Fig. 10 deserves attention. It was stated that according to the action on pouring, the heats with strengths from 45 to 50 kg. tended more to form surface cracks, but the result of the preliminary test did not confirm this assumption. Fig. 10, on the other hand, which shows the average yield of sheets with sound surface for strength limits from 36 to 40 kg., 40 to 43 kg., 43 to 46 kg., and 46 to 50 kg., proves that actually the harder materials tend somewhat more to the formation of the surface cracks. There is another reason for making this statement, which will be taken up later.

References

1loc. cit. p. 16.
6loc. cit. p. 185.
12loc. cit. p. 160.
13loc. cit. p. 173.
14loc. cit. p. 176.
16loc. cit. p. 176.
17loc. cit. p. 209.
20loc. cit. p. 17.
21loc. cit. p. 208.

(To be continued)

Data on Pig Iron Production

Following is an annual statistical report for 1930, published by the American Iron and Steel Institute, on the production of coke pig iron per blast furnace day:

Average Production of Coke Pig Iron per Blast Furnace Day:

<table>
<thead>
<tr>
<th>Years</th>
<th>Furnaces in blast</th>
<th>Days in blast</th>
<th>Coke pig iron produced, gross tons</th>
<th>Pig iron per blast furnace day, gross tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1926</td>
<td>264</td>
<td>76,923</td>
<td>38,534</td>
<td>597.9</td>
</tr>
<tr>
<td>1927</td>
<td>240</td>
<td>67,854</td>
<td>35,693</td>
<td>526.0</td>
</tr>
<tr>
<td>1928</td>
<td>235</td>
<td>65,684</td>
<td>37,258</td>
<td>567.2</td>
</tr>
<tr>
<td>1929</td>
<td>236</td>
<td>71,122</td>
<td>41,619</td>
<td>585.2</td>
</tr>
<tr>
<td>1930</td>
<td>201</td>
<td>51,242</td>
<td>30,924</td>
<td>603.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coke Pig Iron Produced per Blast Furnace Day by Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1926</td>
</tr>
<tr>
<td>1927</td>
</tr>
<tr>
<td>1928</td>
</tr>
<tr>
<td>1929</td>
</tr>
<tr>
<td>1930</td>
</tr>
</tbody>
</table>

South—Includes Alabama and Tennessee.
Atlantic—Includes Massachusetts, Eastern New York, Eastern Pennsylvania, Maryland and Virginia.
Lake—Includes Western New York, Western Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Illinois, Michigan, Wisconsin and Minnesota.
Uniformity of Quality in Coking Coals*  

By RALPH H. SWEETSER

Need for uniformity in the raw materials going into the iron blast furnace is so well recognized in present day practice that it requires no further comment; but uniformity in the quality of the coking coals going into the by-product coke ovens is not so well established in the minds of those men responsible for the management of integrated steel plants. By uniformity of quality in coking coals is meant, within the scope of this paper, dependable regularity in the percentages of moisture, of ash, of sulphur, and of fixed carbon in the coals as received at the coke ovens. Only coals for blast-furnace coke will be discussed in this paper, but the need for uniformity in coals for foundry coke and domestic coke is just as great if the producers give quality of products its proper place in their business.

When a decision has been reached as to the coal mixture and its limits as to the proportion of high volatile and low volatile coal, or whether there shall be only one coal in the mix, the fluctuations in the quality will be chiefly in the ash, in the sulphur, and in the moisture. Except in cases where bad judgment was used in the selection of the source of coal supply, the percentage of ash and of moisture can be controlled to a great extent right at the mine in all sizes that are large enough to be hand picked, provided that picking tables and enough slate pickers are used. But such a method cannot be used for removing slate in the slack coal and this is the usual size for the coke ovens.

Remarkable results have been obtained by careful mining and hand loading at the face of the mines in certain regions of West Virginia and Kentucky. It is possible to get limited tonnage of coking coals with ash as low as 3½ to 4 per cent in the Elkhorn region of Eastern Kentucky. Such a case was brought to my attention recently, but we must recognize the fact that such clean coal is more likely to be produced in times of depression and excess of miners than in times of much business activity.

Selective Mining

By far the greater proportion of coking coals now used for blast furnace coke cannot be mined without more or less of extraneous ash material getting mixed with the coal as loaded into the mine cars. Only by selective and fortunate purchase, and by selective mining can results like that quoted above be obtained. In this connection, I am reminded of a recent conversation with Mr. James Farrell, President of the United States Steel Corporation. We were discussing the advantages of getting low ash in coking coals for blast furnace fuels, and the evaluation of 1 per cent of ash in coking coal. He said, “How do you get such low ash coal if you don’t wash it?” I replied that the coal region and coal mine had to be selected. Suddenly, he said, “You are a Yankee... What part of New England did you come from?” I replied, “From New Hampshire.”

Mr. Farrell said, “I was born in Connecticut. You know we Yankees have a saying that if you eat the sound apples out of the barrel and leave the speckled ones, you soon have nothing but rotten apples left.”

If you mine only the best of the coal and leave the poorer coal you will soon have your mine in bad shape and will get a very low recovery of coal.

Such a logical statement made me think of the several cases of bad conditions encountered in some West Virginia and Kentucky coal mines that had come under my personal observations. Whenever the demand for coal approached the capacity of the mine and when there was plenty of work for the miners, then there was a falling off in the quality of the coal sent to the coke ovens and to the gas producers. Under such pressing demands for tonnage it was hard to keep good miners in working places that had unusually bad roof conditions or extra dirty coal, and the coal loaded was either dirty when shipped or was so very dirty that it was sent to the slate dump. There have been many periods during the past ten years when considerable good coal was sent to the dump because there was no cleaning plant at the tipple. Previous to 1921 such dirty coal was shipped to market regardless of its high ash content, and again in 1923-4 for a short interval.

Clean Coal Campaign

The clean coal campaign started by the members of the Southern Ohio Pig Iron and Coke Association early in 1923 had much resistance to overcome, even among the blast furnace men themselves. The opposition of the coke oven men gradually disap-

*Presented at mid-winter meeting of the Eastern States Blast Furnace and Coke Oven Association, Pittsburgh, Pa., Feb. 13, 1931.
peared when they realized the gains to be had in more by-products and less breeze, and in better coke when they used coking coals of uniform quality. It took longer to convince the coal operators, especially those who were not connected with captive mines. They naturally asked why they should clean their coal unless they got more money for it. Of course the answer today is that they may not get any money at all for their coal unless they produce it clean enough to meet the demands of enlightened consumers. Last of all to be convinced are the "higher ups," the men who must say "Yes" to increased capital investment. Unless the technical men and the operating men can give sufficient proof of the economies and sales advantages of cleaner coals then the financing of cleaning equipment will be further delayed.

In his paper on the "Influence of Washing Coal on Coke Properties and on Gas and By-Product Yields" presented at the Production Conference, American Gas Association, Cleveland, Ohio, May 23, 1930, Dr. A. C. Fieldner of the U. S. Bureau of Mines (Report of Investigations, No. 3020, May 1930, U. S. Bureau of Mines) said, "The replies to the questionnaire sent out to gas-plant and coke-oven operators were disappointing in not yielding any definite test data comparing unwashed and washed coal from the same mine. It is hoped that plant operators who have the opportunity to conduct tests on coal from the same mine, will do so and report test-data bearing on coking time, oven capacity, flue temperatures, yields of coke, gas, and by-products, and physical properties of coke."

Those of us who have been directly connected with coal mines, coke ovens and blast furnaces all under the same management can easily understand the many difficulties that prevent the collection of reliable data of such a test as hoped for by Dr. Fieldner; and if the mines, coke ovens and blast furnaces are under separate ownership such a test is well-nigh impossible. Considerable preparation must be made before such a test can be carried out, and the movement of coal from the mines to the coke ovens must dove-tail in with other shipments and the coke made from a certain coal must be made in separate ovens and kept separate in the shipment to the blast furnaces; and then the blast furnace man must be sure that he is using only the coke that came from the particular coal under observation.

In June, 1926, it was suggested that a complete coking test be made on the coal from the West Virginia mine referred to above. The seam being worked is the No. 2 Gas, which is known also as Campbell Creek, Upper War Eagle, Freeburn and Burnwell, in the Thacker District. Following is a quotation from the coal catalogue of 1926, page 856: "No. 2 Gas Coal is a good coking coal and is now extensively used in the by-product industry, being mixed with a lower volatile New River or Pocahontas coal in such proportions as to produce a coal of about 27 per cent volatile matter." I had personally used bee-hive coke made from another No. 2 Gas Coal.

Laboratory tests of a carload of this coal had been made at the experimental coke oven plant of Ohio State University, Columbus, Ohio, with satisfactory results, but only a blast furnace can give the conclusive answer to the coking qualities of any coal. The ultimate analysis of the coal compared with two Kentucky coals which were known to make excellent blast-furnace coke is shown in Table I.

Not until the following January was it possible to readjust shipments of coal from the West Virginia mine, so that about 450 tons of that coal could be shipped daily to the by-product coke ovens, replacing the same amount of the Kentucky coals, which had to be shipped elsewhere. At a conference early in January, 1927, plans were made to start daily shipments of enough West Virginia coal to

The Nemacolin Rheolaveur washing plant of the Buckeye Coal Company, Nemacolin, Pa., which makes a three-product separation—by-product coal, 86½ per cent; steam coal 8½ per cent; and refuse 5 per cent. Rated Capacity—650 tons per hour.
make 350 tons of furnace coke to be used exclusively in the furnace of one of the owners—the test to continue for at least a month.

Since it was desired to know the coking qualities of clean coal it was decided to ship only lump and egg sizes to the coke ovens as all this coal was hand-picked and supposed to be clean. The analysis of the coal shipped from the West Virginia mine for the month of November, 1926, averaged as shown in Table II:

<table>
<thead>
<tr>
<th></th>
<th>Lump per cent</th>
<th>Egg per cent</th>
<th>Nut and Slack per cent</th>
<th>RO.M. per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash</td>
<td>5.00</td>
<td>7.26</td>
<td>12.68</td>
<td>8.38</td>
</tr>
<tr>
<td>Sulphur</td>
<td>.85</td>
<td>99</td>
<td>1.26</td>
<td>1.03</td>
</tr>
<tr>
<td>Moisture</td>
<td>2.95</td>
<td>3.10</td>
<td>4.20</td>
<td>3.43</td>
</tr>
</tbody>
</table>

Table II—Average Analysis of Shipments

To show what operating difficulties had to be adjusted at the coke ovens I will quote a part of a letter from the General Manager, who said, “Of course, you realize our operation is already complicated with the foundry coke production, and this introduces another complicating factor which would require very exact scheduling of the operation in case the other customers were not desirous of having anything other than their standard mixture.” This was the case, but in spite of all the many obstacles the test went forward according to schedule, just as is the case whenever operating men of the coal mines, coke ovens and blast furnaces get together and talk over their problems.

First, a preliminary shipment of three cars of the West Virginia coal was made with the results shown in Table III.

“Top” samples of coal were those taken from the top of car on arrival, and the “unloading” samples after the coal was crushed and on the elevator to the mixing bin.

The lack of uniformity in analysis is here clearly seen. I have no explanation to offer regarding the higher ash, higher volatile matter, and the higher sulphur in the unloading samples as compared with the results in the samples taken from the tops of the cars.

**Final Test**

The regular test was started on January 23, 1927, when the first West Virginia coal was charged into the ovens; the mix was 85 per cent of West Virginia and 15 per cent Pocahontas, and the use of West Virginia coal in the mixture continued for 34 days, producing enough coke to run one blast furnace from January 28 to March 6, inclusive, a total of 38 days.

Irregularities cropped out immediately. No one was satisfied with what he was doing himself, neither was he satisfied with what the other two superintendents were doing.

The coke oven superintendent said in his report, in part, “In all fairness to the operators at the mine, I do not think they realized how strict the requirements are on coal for making by-product coke, for they have been shipping coal for producer operation. Producers are operated for gas alone. The impurities in the coal would not effect producer operation, while at our plant coke is the chief product and the impurities of the coal are carried into the coke. The improvement in the quality of their coal during the last period of the test was an indication that they realized that producer and by-product coking coals are entirely different, but to properly clean the West Virginia coal in question offers a real problem.”

But the coke oven superintendent confessed his own lack of uniformity by saying, “We were unfortunate in making a test during this period for we were relining ovens and increasing our furnace and foundry production, all of which caused considerable variation in coking time. The increased foundry production alone caused a total variation of four hours in furnace coking time, and we were compelled to carry higher heats to take care of the minimum coking time.”

The blast furnace man was unfortunate, too, for he said in part, “It is unfortunate that during this test conditions beyond the control of the oven management necessitated changing the speed of the ovens several times, causing ovens to be pulled too soon or held over after the coking process had finished because of interference from the production of foundry coke. This irregularity no doubt affected to some degree the quality of the furnace coke produced.”

“The West Virginia coal used in this test did not get sufficient pulverization, and as a consequence there was a great deal of large slate chips imbedded...
in the coke, creating a weakness in its structure. The very nature of this coal would require extremely fine grinding and extreme care in mining and cleaning. Taken as a whole, the ash and sulphur in the coke made from the West Virginia coal were very good, though there was too much variation in the ash from day to day. The blast-furnace manager further explains that "At the time this coke went in the furnace we were nearing the end of a run on 1.75-2.25 per cent silicon malleable iron."

Then the Assistant to the Vice President came in with his report and said, "The coal mine, the coke ovens and furnace, with all their varying conditions, were very closely tied together in the final result which was good pig iron at low cost. The irregular excess ash in this West Virginia coal caused a higher pig iron cost than was necessary. The final cost of the pig iron was only $0.038 more than the lowest cost in the past 10 months. The big trouble with the coal was the fact that 75 cars out of 269 had higher than 9 per cent ash and these cars were supposed to be hand-picked. The lowest ash reported was 4.40 per cent, and the highest 14.32 per cent, a spread of 9.92 per cent; the highest ash was more than 300 per cent of the lowest, and almost double the average ash."

The coal mine manager did not make a report on this test, but I imagine it would have read something like this—"The roof conditions are bad and the draw-slate is heavy in some of the entries. The fireclay bottom sometimes gets mixed with the coal, and of course the slate pickers can't see all the slate in the egg size when there is a rush of coal on the picking tables; and you know that the movement of the Marcus screens helps to put the heavy flat slate on the bottom of the stream of coal out of sight of the pickers. And besides that I don't see why those coke oven men are so particular anyhow."

In my opinion there is nothing like a complete coke oven test, such as this one, for bringing out the actual practice and the quality of products at coal mines, coke ovens, and blast furnaces. It is then that the coal man, the coke man, and the pig iron man all realize that they are interdependent and must all work in unison in order to get satisfactory final results, low-cost, high-quality pig iron and plenty of it. Such a co-ordinated test concentrates the attention of the general management and of the respective superintendent on the main objective better than any other method. It is better than a whole flock of conferences without the test, but conferences of all concerned are necessary before and after such an investigation.

Excellent coal was being shipped in some cars, and bad coal in others; excellent coke was being pushed from ovens where all the conditions were right; excellent pig iron was being made when all irregularities were evenly balanced; but the lack of uniformity in the quality of the coking coals upset all that excellence all along the line.

It is fair to say, right here, that this acid test resulted in the elimination of many of the sources of irregularities in quality of coal, coke, and pig iron. A coal washer, a separate coke whari and separate ovens for foundry coke were installed; regularity of the quality of coke resulted in better, cheaper, and more pig iron.

(Concluded in the September issue)

Lubricating Open Gears

By G. H. Olson

Manager Crane and Shovel Division
Link-Belt Company, Chicago, Ill.

OPERATORS of cranes, excavating and other machinery will find the following home-made mixture an especially efficient lubrication for open gears:

- White lead .......... ½ lb.
- Cylinder oil .......... ½ gal.
- Flake graphite .......... ½ lb.

It will be found that this mixture adheres well to the gears and that it can be painted on with a brush, as required, at intervals of about five hours.

The graphite and oil form the lubricating content of this mixture. The white lead acts as a binder and keeps the gears from cutting.

Cup grease may be substituted for the cylinder oil. The graphite may be omitted, but it is not advisable to do so in warm weather.

Some of the standard gear compounds may be used with good results, but they have a tendency to run off the gears and get in the frictions of excavating machinery, usually resulting in a dirty machine. However, most of these compounds may be obtained in grades that are suitable for use in various temperatures.

The white lead mixture may be made heavier for warm weather by using less oil or grease in proportion to the quantity of flake graphite.

Above all, keep all moving parts properly lubricated for increased life and efficiency.
Pulverized Fuel Distribution in the Steel Plant

By J. GOULD COUTANT

The great obstacle to be partially overcome before the return of another boom era is the excessive cost of distribution, particularly that of energy, which affects the cost of everything that is manufactured.

In recent years railroads have shown their ability to transport energy in the form of coal and oil for less money than it can be transmitted by high-tension lines.

While large scale pipe line development for oil, though comparatively new, has taken away large tonnage from the railroads, the high pressure transmission of natural gas through pipes has shown greater economy than the piping of oil.

Further, pulverized fuel, using high pressure air or gas as a supporting medium, can be transported through pipes at a substantial saving over gas transmission; four to five times the amount of energy in gas can be carried for a given pipe area.

The distribution of pulverized fuel through pipe lines has now been in operation for more than fifteen years without the necessity for renewals of bends owing to pipe corrosion and deterioration. Also, indications are that the frictional losses for this method of distribution are not more than those for gas.

The latest report by the Bureau of Mines on the growth of energy sources shows that bituminous coal remains the principal source of energy. Although the chart, Fig. 1, shows the abrupt decline since the year 1918 from the normal rate of increase resulting from the advance in freight rates. In consequence, there was brought about greater efficiency in fuel burning equipment and impetus was given to pipe line distribution for natural gas, increasing the consumption as shown in the chart, while that of fuel oil increased correspondingly.

The transmission of pulverized fuel by compressed air has been the practice in many copper smelting and steel plants, in many cases a distance of one mile from the point of pulverization.

Following is a description of the general arrangement of a 4 in. I. D. transmission line installed at the steel plant of the Societie Anonyme Ougree-Maribuye, Ougree, Belgium, which distributes to various points of utilization by the blow tank method of transportation.

The dependability of this means of fuel distribution becomes obvious when it is noted that one 4 in. line supplies fuel for the entire plant, including boilers and furnaces. The main transmission line is supported outside the pulverizing plant on a

Fig. 1—Relative rate of growth of coal, natural gas and water power in the United States
series of towers or poles; then along a building on brackets. In some places the line changes its direction, ascending approximately 35 ft. and descending the same distance. The pulverized fuel is diverted through branch connections to bins at points of utilization, which are controlled by special valves placed in the main transmission lines. The branch lines end in a cyclone separator where the small amount of air escapes to the atmosphere through vents and the pulverized fuel follows into the bin.

The main line passes outside the pulverizing plant, over a traveling crane and storage yard, across the public highway, and descends on a bridge over the North Belgium Railroad, which separates the north and south parts of the steel plant. The line then follows along the tire mill to the furnaces, all of which are fired by pulverized fuel.

Powdered fuel Bin No. 1 supplies fuel to four tire annealing furnaces, and to an axle annealing furnace. Bin No. 2 furnishes fuel to a continuous double heating furnace, for heating round tire billets, and which is inclined to allow the billets to roll through, and also furnishes fuel to two hammer furnaces. Bin No. 3 supplies fuel to a large continuous furnace which heats ingots for the steam hammer. On this hammer axes are forged and tire billets are blocked. The fuel consumption of the furnaces is 240 lbs. per ton for tire billets and 220 lbs. per ton for axles.

Bins No. 4 and 5 supply fuel to double continuous furnaces at the rail mill, in which 2,000 lb. ingots are charged hot, with a fuel consumption of 55 lbs. per ton.

Between bins No. 4 and 5 the main transmission line branches, one leading to the boiler house and the other extending to bins No. 6 and 7, which supply fuel to two continuous furnaces; these are charged with 4500 lb. billets for the heavy plate mill, the fuel consumption for cold charged billets being 230 lbs. per ton, and for hot charged billets, 175 lbs. per ton.

Bin No. 8 furnishes fuel to a continuous furnace, which is charged with hot 2 in. square billets for a small train of rolls, the fuel consumption being 85 lbs. per ton. Bins No. 9 and 10 serve small furnaces for rolls.

Bin No. 11 supplies fuel to soaking pits. Boilers are supplied by fuel from bins Nos. 12, 13, 14, 15, 16, 17, etc.

The fuel used at this plant had heretofore been considered waste fuel, rejected from the mines—a semi-bituminous coal, 15 per cent ash and 17 per cent volatile.

The pulverizing plant is located in what will be the center of the steel plant. The main transmission line now extends northward a distance of three-quarters of a mile through which pulverized fuel is transported at the rate of 1000 to 2200 lbs. of coal per minute through a 4 in. 1. D. pipe.

The compressed air used during the time of transport is approximately 1 cu. ft. of free air for 1 to 3 lbs. of coal delivered. The system has been in use ten years, transporting high ash refuse coal; to date no repairs to the line have been necessary.

The success of this and other systems that have been in operation for a long time suggests a means of distributing all fuel necessary for large copper smelting and steel plants; this method could readily be adopted for supplying fuel to central power stations in cities like New York and Brooklyn or to large office buildings now burning fuel oil and coal. Transmission lines which are very small in diameter could be located in subway systems and tunnels to the point of utilization without any hazard and at relatively small expense, permitting preparation plants to be located where land is least expensive, making room for greater boiler plants to be built within the city.

Model of Blast Furnace

The illustration shows a model of a typical German blast furnace. Note the "housed-in" construction. All details of the original blast furnace have been reproduced. The charging device is operating. Schumann engineering models as supplied by the Paul F. Hermann Co., Pittsburgh, Pa., are made true to any desired scale with or without cut sections. Such models are useful at exhibitions and conventions, particularly if space is limited, expensive or lightly constructed. Models are a help to the salesman and attract attention at the executives' offices. Schumann models are neatly made, are accurate to the minutest detail. There are decided indications that American executives, recognizing both the sales and educational values of good models, are planning a wider use of them.

Model of German blast furnace into which are incorporated all the details of the original
Cooperative Research in the Iron and Steel Industry

By F. N. SPELLER

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PART III

The Board, through its committees, was organized to cooperate with the Bureau of Mines and the Institute in the selection of problems and in the general supervision of research work. Several problems dealing with refractories, the cause and control of abnormality in steel, and corrosion were first undertaken. In 1926 the Board voted to undertake a five-year program on the study of the physical chemistry of steel making, including in particular the study of non-metallic inclusions, their nature, properties, methods of determination and elimination. Dr. C. H. Herty, Jr., was engaged and was assigned by the Bureau of Mines, with other assistants from the Bureau, to work on this problem. The results of this work have been published from time to time in a series of bulletins and in technical papers, so that this work is now well known throughout the metallurgical world.

It was necessary in starting this work to make a fundamental study of the solubility of FeO in molten steel at different temperatures, and methods for the determination and separation of these impurities. Equilibrium conditions between these constituents in the molten metal and various kinds of slags were then determined, and their reactions with aluminum, silicon, and manganese were studied with a view of finding the type of inclusion that can be most readily eliminated from the metal. This required a great amount of painstaking preliminary work on the part of the research staff, much of which was original. One result of this work has been the determination of the most suitable proportion of manganese to silicon in deoxidizing alloys to give fusible inclusions that will coalesce and separate quickly into the slag, this being the most economical type of alloy available for this purpose. A special spiegel or silico-manganese alloy containing from 4 to 5 parts of manganese to 1 part of silicon seems to be the most effective. During the past year plant tests have been under way with the object of testing and adapting the use of deoxidizers to open-hearth practice.

The indications are that it will be practicable to make cleaner steel, perhaps at lower cost, by the use of a deoxidizer of this type instead of using ferromanganese and ferro-silicon separately in finishing the heat. Whatever the final economic result may be, our knowledge of the reactions in the open-hearth bath and the fundamentals of steel making has been considerably advanced by this work. Much remains to be done on the practical application of these principles to the improvement of the open-hearth and Bessemer process and on the study of the influence of non-metallic constituents on the physical properties, weldability, corrosion, and defects of steel.

The original five-year program will be completed this year. The Metallurgical Advisory Board hopes to continue the work for another period of three years and trusts that it will be possible to retain the present organization for this purpose. The new program includes further study of: the refining of steel in the electric, open-hearth and Bessemer processes, strong deoxidizers, elimination of non-metallic matter, gases in steel, quicker methods of determining inclusions, and the influence of these inclusions on the physical properties of the finished steel, and allied problems. The plant work will be carried on at convenient locations, and bulletins issued from time to time so that those interested will be promptly informed of results.

The present accomplishments resulting from work done on this problem are briefly, (1) the determination of solubility of iron oxide in pure iron and the correlation of the iron oxide content of open-hearth steel with this solubility curve, including the development of the aluminum method for determining in a relatively short time the iron oxide in steel, and the determination of the relation between carbon and FeO contents in liquid steel and slag of various composition; (2) completion of the entire program on formation and identification of non-metallic inclusions whose base is FeO, and work on deoxidation with manganese-silicon alloys; (3) the development of the electrolytic method for determining non-metallic inclusions in steel; (4) the determination of melting points and viscosities in various slag systems, these forming a solid founda-

*Paper presented before the American Iron and Steel Institute at New York, May 22, 1931.
tion for future work on deoxidation and slag manipulation in the open-hearth furnace; and (5) the application of the above to open-hearth work in the production of steel of greater cleanliness than has been obtained by present-day steel-making practice. Practical tests on acid and basic open-hearth heats already show on the average a distinct improvement in quality and rejections where these principles have been put into practice at three plants.

In October each year for the past four years a conference has been held in Pittsburgh to discuss informally the results of the work done. Last year this meeting was attended by 347 metallurgists or open-hearth men, compared with 67 at the first conference.

The Bureau of Mines, feeling that its function as a government institution is to initiate and assist in investigations of this kind until the results justify the interested industry in taking them over, has decided to utilize its resources on other problems after January 1, 1932. The Advisory Board trusts that a plan will be found whereby this work may be continued for a further three-year period. It would seem that this is an opportunity for the industry as a whole to take over this going organization with the co-operation of the Carnegie Institute of Technology and others who may be interested.

Consumers' Problems

Important co-operative work is also sponsored by groups of consumers, such as the work done on elimination of corrosion by the American Society of Refrigerating Engineers, National Electric Light Association, American Petroleum Institute, and American Gas Association. Manufacturers have been called on to assist and have often taken an active part both in financing and advising on work of this kind. The results of such research often have an important influence in widening the field of use of steel.

Corrosion of metals is a world-wide major engineering problem of particular concern to consumers. It is also a problem of much interest to manufacturers of metals, who are naturally competing with one another to produce metals that will be better adapted to withstand the various conditions of service. The economic solution of this problem is, however, not necessarily through the development of more resistant metals, although much remains to be done along this line. The practical solution of this problem on the other hand has frequently been accomplished by some treatment of the corroding media that will remove the cause of the trouble, or by the application of suitable protective coatings. Evidently this is largely a non-competitive problem, so far as the iron and steel industry is concerned, and therefore one that may be best handled on a co-operative basis. It is also typical of certain problems in which consumers and producers may work together to common advantage, and through this contact may obtain a better understanding of each other's problems, and a mutual confidence one with the other.

Perhaps the largest piece of co-operative work of this kind is that organized under the American Petroleum Institute in 1926 for the purpose of studying corrosion in the oil industry, in co-operation with the Bureau of Standards and several manufacturers. This work is now divided between two main committees, one helping to do with refinery and marine problems, and the other with transportation and production problems. The latter maintains a full-time associate working with the Bureau of Standards on the study of soil corrosion and protective coatings. Paid associates have also been placed at the Bureau by the American Gas Association and the Cast Iron Pipe Research Association so that the study of soil corrosion in this country may be said to center in the Bureau of Standards, where eleven men are now working on this problem, eight of whom are employees of the Bureau. The industries co-operating also contribute a considerable amount of time and material toward this work. An advisory committee including representatives of all interests meets once a year to review and assist in laying out further work on this subject. The technical committees of the American Petroleum Institute and American Gas Association meet semi-annually.

The Bureau of Standards' soil test on standard pipe materials was started in 1922 by co-operation between the Bureau and several pipe manufacturers and is now consolidated with the general co-operative study of soil corrosion. This work includes the study of the various factors in soil corrosion leading, we trust, to a reliable measure of soil corrosivity and correlation of results of experience with laboratory tests. Extensive field tests of protective coatings are also under way.

It is evident from a study of the data of these tests that, so far, on the average no material difference in durability is indicated between any of the wrought ferrous metals; that the rate of penetration is diminishing with time; and that physical and chemical soil variations control the rate and character of corrosion.

Another similar example of co-operative work, completed in 1928, on prevention of corrosion in refrigerating brine tanks was carried through by a small committee of the American Society of Refrigerating Engineers and steel manufacturers. This problem was solved in two years at a total cost of about $16,000 (including expense of attending meetings), one-half of which was subscribed in funds contributed mainly by the refrigerating industry. A research associate was placed at the Massachusetts Institute of Technology to make laboratory tests and to superintend plant tests, thus relieving the committee of all details and greatly expediting the work. The industry estimates that the annual saving resulting from this work, in depreciation and increased efficiency, is many times the total cost.

Co-operative research on such problems often helps to retain the use of steel in a field which other-
wise might be occupied by some more durable but relatively more expensive material, and at the same time helps to develop trained technical men for the industry. Technical data obtained co-operatively and endorsed by an industry working together sometimes carry more weight than that secured through the efforts of one concern, and can be obtained at relatively lower cost to each of the participating interests.

Most co-operative work naturally centers around a committee of those best able to assist in the work, who should be responsible for planning and supervising the work in a general way, but unless some one individual is responsible for keeping things moving, committee work is apt to lag, especially if the members of the committee have many other important duties. Rarely can a volunteer committee carry on an important investigation promptly and efficiently without a paid associate whose main business is to follow up the details of the work as planned by the group. By this means the time of the advisory committee is saved and the work can often be carried out in shorter time and at lower cost than when directed solely by voluntary effort. It is usually difficult, however, to estimate the actual cost of co-operative research for lack of sufficient records.

Then there is, of course, always the fundamental problem of financing projects of this kind, but surely there is no reason in this country to anticipate difficulty in financing a well-planned useful piece of research work of benefit to the industry at large. All of the preceding leads us to the question, What can and should be done by the American steel industry as a whole toward planning, co-ordinating, and financing co-operative investigations?

Conclusions and Recommendations

It will be seen that a large amount of co-operative research work has already been done in this country under many agencies, working independently, such as educational institutions, government bureaus and engineering societies. The valuable results already obtained in many cases, through the initiative exercised by these groups, lead us to feel that in the future similar work can be done more efficiently and more economically with proper co-ordination. It would seem therefore that the time is near when non-competitive problems should be sponsored by this industry as a whole, with the full co-operation of those who are able to actively assist in such work. Co-ordination should result in better planning and greater economy of execution.

To this end, it is suggested that co-operative work in this industry be centered in a research board, under the auspices of an association of iron and steel manufacturers, including advisory members representing co-operating interests. The duties of this board would be:

(a) To investigate, approve, and assist in planning work on non-competitive technical problems submitted for consideration by member companies or responsible associations of engineers or consumers.

(b) To budget the cost of each piece of work and arrange for financing after the problem has been approved as being one of interest and value to the industry as a whole.

(c) To decide on location and assignment of the work.

(d) To make contact with similar research associations at home and abroad.

(e) To establish means for publication and discussion of results. For this purpose an official means of publication might be desirable, with permanent facilities for abstracting and printing all technical literature and reports of general interest to the industry.

As there are many institutions in this country equipped for laboratory work, the location selected for any specific job would depend upon where the work could be done to the best advantage. Later on technical institutes for iron and steel problems might be established by the industry in important industrial centers.

As a first step in this direction, it has been suggested that the industry take over and put on a more permanent basis the co-operative metallurgical research work now being carried on in Pittsburgh.

References

"Research," by C. M. A. Stine, Mining and Metallurgy, May, 1930.


Bureau of Standards Technical Bulletin No. 95, Soil Corrosion.


"Research—the Only Defense Against Inter-Commodity Competition," by T. M. Switz, Iron Age, March 19, 1931, p. 990.


Annual Statistical Report for 1930

The Annual Statistical Report of the American Iron and Steel Institute for 1930 has just been published. It contains full and complete statistics of the Iron and Steel Industry for the United States and Canada for 1930 and prior years; also foreign statistics for leading countries for iron ore, pig iron and ferro-alloys, and steel ingots and castings from 1905 to 1930 so far as available; also an analysis of the tonnage of iron and steel products exported, showing exports for the years 1926-1930, inclusive, by certain countries and by geographical divisions.

The report contains 126 pages. Its price, bound in cloth, is 5 per copy. Checks and money orders should be made payable to the American Iron and Steel Institute.
A review of certain
Gas Producer Practice*

By VICTOR WINDETT
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Cleveland, Ohio

PART III

HARMFUL consequences of remote producer control from the open-hearth charging floor are of the following nature: A layout of this kind generally involves a long steam line leading to the gas producer blower. It is common experience that the insulation of such steam piping is not well maintained. It is reasonably certain that wet steam, carrying at times "slugs" of water, will be delivered in this way into the producer air supply. Steam of this quality chills the fire, causes a low CO and high CO₂ and excessive moisture in the gas. The gasification rate falls also. The addition of 1 per cent of moisture to the gas increases the fuel cost as much as though the CO₂ content had increased 2.25 per cent.

Another consequence is that remote control induces irregularity in the gasification conditions of the producer, as the gas man has no way of discovering that the rate of air supply has been changed, except as he looks from time to time, through an observation hole into the producer. Then he notes a considerable change in the fire level, or in the apparent gas temperature, or the appearance of more or less incipient holes in the fire. His remedies are to alter, by guess, the rate of coal feeding (not knowing the actual rate of air supply), and possibly doing a certain amount of haphazard hand poking. He sees the fire conditions becoming poor, and the quality of the gas fall off. A gas man, newly employed, soon learns that he is thus hopelessly handicapped, acknowledges he is beaten, by circumstances beyond his control, and contents himself with merely holding his job, accompanied with as little "ragging" as possible from all of his various bosses. These are: the gas house foreman, the open-hearth superintendent, and the combustion engineer, all of whom feel qualified to tell him how to do his work.

The generator tender in a power station, as he sees his load fluctuate, does not adjust the feed water valve of the boilers, in the somewhat remote boiler house, to meet every change in current output. This detail is in the hands of the water tender in the boiler house. The reason why a similar condition does not exist in gas making is that logical thinking and acting are not always carried to a conclusion.

Let it be repeated, the gas man must be responsible for both quality and quantity of his gas, and make delivery at the desired time. Do not allow the melter or any one else to interfere in a situation where he does not belong. The question goes up to the plant manager. In this connection, it may not be amiss to suggest the good business of respecting the gas house foreman's position, by dealing through him instead of going over his head direct to the gas man, as is done in more than one plant.

There is a tendency to place undue importance on the gas temperature at the gas exit of the producer. The proper temperature is that at which the combustibles of the gas are at a maximum. In addition to this, experience teaches that certain coals of a strong coking tendency require a somewhat higher temperature than weaker coking coals. With an understanding of these things goes the desirability of a uniform temperature, for uniformity is good in almost all continuous operations. Aside from these considerations, temperature is not of much concern.

The important thing is to deliver into the furnace a maximum of heat of combustion of the gas and its accompaniment of tar vapor and coke particles. This heat of combustion will approximate 82 per cent of the total heat of the gas. It is of little use trying to deliver more heat to a furnace by making an unduly hot producer gas.

The customary procedure to lower the producer gas temperature, when it is deemed too high, is to quickly feed in a considerable excess of coal, regardless of the fact that soon this coal must be gasified.

The correct way to lower the temperature is to diminish the thermochemical heat generation, by reducing the rate of both coal and air. That is, slowing down the gasification rate.

This leads to another thought. Much is being done in a pioneering way and largely by makers of scientific instruments (to whom much credit is due)
in developing instruments for the control of gas producer working. The duty of a gas producer is to make gas of quality, and in quantity, to serve the

furnace properly, for which it is the source of fuel. Not only must the producer make an adequate supply of gas, but it must function as wanted with a minimum lag between the call for a change of rate of delivery and the effective response in the gas flow. The immediate effect of a change in the rate of gas consumption is to change the gas pressure, in the flue and in the gas chamber of the producer. Nothing is affected as quickly as the pressure. A gas temperature variation is a by-product or collateral consequence, involving an appreciable lag in time, when it is used for producer control.

In discussing W. P. Chandler’s paper* on steel heating furnaces, read at an Institute meeting in 1922, Prof. Trinks brought out the unreliability of temperature measurements by a thermo-couple in a thick protecting tube. It is well known that a thermometer in sunlight, or a wall in the sun, has a different temperature from the surrounding air. Also we know that the air temperature fluctuations are more rapid than those of the mercury in the thermometer bulb. The illustration is perfect. We know also that it takes a perceptible lapse of time for a change in the gas temperature to be transmitted through the thick protecting sheath and the inner porcelain case in which the thermo-couple is placed before the thermo-couple is registered on the recording chart of the pyrometer. The record on the chart is always behind time and to a variable extent. Prof. Trinks indicates that the lag may be equivalent to an error of 50 deg. It is even a question whether the actual temperature is indicated or not, because in addition to the lag in the pyrometer, in rapid temperature fluctuations, the full effect of a temperature change does not penetrate completely through the protective coverings of the couple before another variation occurs. Thus the indications on the chart are “damped.” By the time the thermo-couple has experienced the final temperature drop or rise, the need for its control either is past or is aggravated by the lag of the instrument.

These circumstances point to the desirability of actuating control instrument by the gas pressure rather than by the temperature. A mechanical, automatic, modern gas producer, of the best type, equipped with steam-driven turbo-blower, and mechanical, automatic, coal feed of the double bell type, similar to the well known, gas tight blast furnace top, is admirably adapted to the close regulation of coal, air and steam (for blast humidification), both concurrently and individually, and in proper proportions, for varying gas demands, while always maintaining correct conditions within the producer. The pressure impulse may be received through a diaphragm or by a floating bell. This latter device may be of the kind developed at one of the plants of the National Tube Company in Pittsburgh, and commercially by a number of instrument makers.

Gas Pressure Control to Coal Feed

The application of the principle of gas pressure control to a coal feed is a simple matter. Considering the type known as the double bell feed, the coal enters from an overhead coal bin over the paws of a superimposed measuring pawl and ratchet-driven wheel. The paws are driven through a reciprocating arm whose virtual length depends on the distance of its point of attachment from its pivot. To make this variable, securing thereby a change in the quantity of coal delivered, this point of attachment is a threaded nut traveling on a threaded swinging shaft. The rotation of this shaft determines the position of the nut, and the device is operated by hand or by a small motor mounted on the shaft. The motor runs plus or minus by impulses received from a diaphragm exposed to the gas pressure acting on a solenoid brake.
The variation in hourly rates of feeding of coal shown in data collected was secured by manual control. The adjustment of the feed ranges from nothing up to 8000 lb. of coal per hour with increments of about 10 lb. per min.

Hand adjustment is possible by using the manual control wheel on the lead screw.

The admission of air is controlled similarly through the gas pressure control acting simultaneously with the coal feed or by manual control, either of which works through the turbine throttle valve. When worked manually the gas man is normally on the gas house operating floor. When the turbo-blower is completely stopped, the air shut-off valve in the air duct is simultaneously closed as the throttle and gate valves are interconnected.

Automatic instrumental control of the saturation temperature of the humidified air, working to a closeness of 1 deg. F. would control the steam supplied to the air by adjustment of the valve through which exhaust steam is admitted to the air conduit under the gas producer.

Each gas producer should have individually a recording thermometer for the humidified air supply, a recording gas pyrometer, steam, air and gas gages and a revolution counter on the coal feed. An adequate steam separator or trap close to the turbo-blower is essential to keep the steam, used to humidify the air, free from water. The air thermometer assists in keeping the steam of the air supply down to a minimum for controlling the tendency of the ash to clinker.

The pressure gages reveal undue resistances through the existence of dense ashes, fire, or flues inadequate in diameter, too long, too many directional changes, or filling up with flue dust. Thus the flue system of two iron and steel plants separated by many years in age show the superiority of flue design in the later plant “C” compared with the older plant “A.”

The flues of plant “B” are considerably longer than those of “C” which is reflected in the higher net effective pressure. The net effective pressure is the blower pressure reduced by the gas pressure, and is the measure of the actual air delivery to the producer; and hence it is the measure also of the capacity of the producer. Other things being equal, the capacity of a gas producer is directly proportional to the amount of air which can be delivered to the combustion zone.

In many plants the pressure of the gas amounting to from 0.35 to 0.75 in. of water pressure, is all that is needed to overcome flue friction and impart velocity to the gas on its way to the furnace.

Compare two flue systems requiring gas pressures at the producer gas outlet of 0.8 to 1.8 in. of water pressure respectively. Assume a blower discharge pressure in the first case of 4.5 in., then the second case would call for a similar pressure of 5.5 in. The increased consumption of power would be

\[
\frac{5.5 \text{ in.} - 4.5 \text{ in.}}{4.5 \text{ in.}} = 22 \text{ per cent.}
\]

This would be a change for which the flue design is responsible and not the gas producer.

The highest development of the gas producer art is found in the producer house, where coal and air, with the accompanying humidifying steam, enter the producer at the proper times, and in the appropriate amounts to deliver the gas in an ever flowing stream, proportional to the demand, but constant in quality and temperature, with a minimum of entrained moisture. This presupposes controlled mechanical coal feeding and spreading, mechanical-poking of the fire, which facilitates and speeds up the thermochemical work in the gasification zone, and assists in the upflow of the gas, especially when using a coking slack coal. Quite as important as these features of a producer is the maintaining in a loose porous condition of the ash bed, through

<table>
<thead>
<tr>
<th>Plant</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal gasifier per producer hour, lb.</td>
<td>4870</td>
<td>5985</td>
<td>7600</td>
</tr>
<tr>
<td>“Fines” in coal, per cent</td>
<td>10-15</td>
<td>63</td>
<td>55</td>
</tr>
<tr>
<td>Pressures in—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Inches at water column)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air duct</td>
<td>9.7</td>
<td>6.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Gas outlet</td>
<td>1.2</td>
<td>1.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Net pressure</td>
<td>8.5</td>
<td>4.7</td>
<td>3.7</td>
</tr>
<tr>
<td>(Lbs. per sq. in.)</td>
<td>105</td>
<td>57.3</td>
<td>74</td>
</tr>
<tr>
<td>Steam at turbo</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Fig. 6—Temperatures of CO formation from CO<sub>2</sub> and coke

Fig. 7—Heat of combustion of producer gas referred to saturation temperatures of air supply
which the air must ascend uniformly to all parts of the underside of the combustion zone. This latter condition is secured and held throughout long periods of the producer operation by periodic loosening of the ash zone, and a continuous ash discharge, in a stream proportional to the rate of ash making, this latter being dependent on the rate of coal feeding. The gas man in charge is no longer constantly engaged in hard laborious effort with shovel, sledge hammer or poking bar in hand, but becomes an observer or watcher of his machines, guided by the indications of scientific instruments of production and control. He has changed from being a worker of muscle and brawn to a man who thinks and acts intelligently.

Figs. 4 and 5 show that in gasifying Pittsburgh Vein coal, the most favorable temperature, from the point of view of the calorific value of the gas, is from about 1300 deg. F. to about 1430 deg. F. Within this range the maximum is found, while at the two limits the calorific value has dropped but 1 per cent. The curves for other coals will be found to be similar in character while varying qualitatively.

The effective gasification temperatures are those found in the fuel bed combustion zone. These temperatures are difficult to measure in producers working in industrial plants. The temperature commonly used in such cases is that of the gas as it leaves the producer, and are the temperatures used in this paper.

The value of a gas depends on the carbon monoxide content rather than on its hydrogen and hydrocarbons. The hydrocarbons of producer gas seldom rise above 4 per cent while carbon monoxide approaches 30 per cent, so that the value of a gas may be estimated, to a large extent, by the ratio CO/CO₂, which should be as high as possible. The CO/CO₂ ratio are found in producer operation where the carbon dioxide is reduced to carbon monoxide. This is in the region of a few inches above the bottom of the combustion zone.

Assuming the conditions of Clement's experimental work, the temperature in this region should approximate 2300 to 2400 deg. F.

High temperature for this work points to the desirability of as low a moisture content in the air supply as possible, considering the need of steam to control the ash clinkering, and also the advantage of a fire of sufficient thickness to hold a high temperature even in the presence of a small amount of excess air moisture.

These considerations lead to Figs. 6 and 7, which are a plotting of the gas calorific value with regard to the saturated air supply. Assuming a permissible variation from the maximum of 1 per cent in the quality of the gas, the temperature of the humidified blast may have a range of from 119 to 137 deg. F. without affecting seriously the quality of the gas. The more preferable gas from a point of view of furnace heating would be that made with the lower rather than the higher saturated air temperature. This is due to the probable lower hydrogen content of the gas, for hydrogen is not as desirable a fuel in a furnace as carbon monoxide.

The amount of moisture in the air for these temperatures will range from about one-fifth to three-eighths of a pound of steam per pound of coal gasified.

In a continuing operation the intensity of the temperature involves to a certain degree the element of time. This is evident when one considers the low temperature of oxidation occurring in the prolonged time for the rotting of wood, as compared with the same quality of oxidation under forced blast conditions in a furnace in a short time.

This points an answer to the advantages of the high gasification rates within practical limits of modern producer operation, whereas in many engineering operations (for instance, in the speed of propulsion of ships) a high rate of output is accompanied by a considerable drop in efficiency.

To secure the best conditions for forming these thermochemical relations there should be a satisfactorily co-ordinated control of the air and coal supply, and also of the quantity of steam added to the air. As the main function of the steam is to control the ash clinkering, this control should be separate from that of the air. The most flexible manner of supplying air to a producer, from this consideration, is the using of a steam-driven turbo-blower rather than a steam jet blower, in which the steam used for air propulsion is mixed inevitably with the air. In using the turbo-blower, such of the exhaust steam of the turbine as is not used for air moisturizing may be thrown into the open air out of doors. Especially important is this advantage of the turbo-blower, when the steam supplied is not dried through the proper functioning of a steam separator and trap, piped into the steam lines. Steam surcharged with water going to the producer, as is the case frequently, is accountable for much bad producer operation and of low value gas.

Substitution of Waste Furnace Gases

Possibly a better means of controlling ash clinkering will be found in the substitution of waste furnace gases rich in carbon dioxide for steam. When this is done the deleterious action of excess moisture is prevented, while the carbon monoxide resulting from the carbon dioxide will increase the calorific value of the gas. A further advance in economy will be taken when these waste gases can be used hot, provided the mechanical details of piping, blower, and attendant expense is not prohibitive.

Gas producer practice is largely empirical, even as medicine is; that is, its experiences in actual
operation form the base of its fund of knowledge. The combustion engineer may theorize but in his advice to the gas man the rule must be written large, 'Don't depart too far, in applying your speculations, from what actual experience indicates is good operation.'

I believe that in times past, physicians made strenuous efforts to lower the high temperature of a feverish patient. At the present time the high temperature of illness is regarded more as an indication of a disorganized condition. The physician's efforts are now directed more effectually to correct the maladjustment of his patient's organism, which when done causes as a by-product a fall of the temperature to a normal figure. The application of this principle in producer practice is to keep the producer functioning correctly and then proper gas temperature will ensue automatically. Hence, the producer control must be directed to the input of raw materials and output of gas as indicated by the gas in the exit flue.

Differences of Opinion on Placing Thermo-Couple

The pyrometric observation of the producer gas temperature is usually obtained by putting the thermo-couple in the gas offtake flue. Some prefer to place the thermo-couple far enough away to avoid the influence of the radiant heat of the combustion zone. Others desire the thermo-couple to receive and transmit to the recording sheet the full effect of the radiant heat as well as that of the gas temperature. This diversity of views must be due to a possible lack of understanding of what particular information in this line is desired, and why it is wanted; that is, of what use the knowledge of the temperature is after it is secured.

The gasification of 111.3 tons of slack coal may be cited in illustration of gas producer practice under partial instrumental control. While the test was eminently satisfactory alike to the mine owners supplying the coal and to the executives of the plant in which the trial was made, it was also gratifying to the manufacturer of the gas producer used in pointing a way to the economical use of low grade fuels.

The purpose of the test was primarily to determine whether or not slack coal of the considerable degree (63 per cent through a ½ in. screen) of fineness of this coal was a suitable fuel for steel works gas producer use. Coals in which the "fines" under ½ in. in size varied from 50 per cent to 90 per cent had been gasified successfully in other plants, yet it was considered desirable to try this special coal, rather than to reason from analogous experience, the reason being that this particular coal ran high in ash content, low in volatiles and was of a strongly coking, swelling nature.

Secondarily, it was desired to learn whether such coal could be used in a battery of producers supplying gas for steel heating furnaces without disturbing the normal furnace practice.

The third purpose was to learn if it was practicable to use a modern mechanical automatic gas producer for gasifying fuel of a hitherto considered doubtful character.

One gas producer of a battery of six, delivering gas into a common header flue was used in testing this coal. The producers were of the modern completely mechanical, automatic, continuously operating type. They were equipped with the double bell coal feeds which are similar in kind and functioning to the well known blast furnace mechanical double bell top. The continuous input of coal and discharge of gas and ashes is facilitated by the beneficial action of the oscillating, inclined poker, the intermittent ash pan rotation, continuously acting plow, controlled to eject ashes at rates proportional to their flow down from the combustion zone, and the turbo-blower supplying air and steam for its humidification, which is controlled in amount independently of the volume of air, but in quantities proportioned for control of the clinkering tendency of the ashes.

The gas from all six producers is used as fuel for the steel heating furnaces of the sheet, bar and jobbing strip mills. Whatever fluctuation there was in the rates of operating the producers was due to putting on or taking off one or more of these furnaces to suit the mill demand for steel.

The instruments with which the producers are provided are a Crowning gas pressure regulator with a recording gauge for the turbo blowers (holding a constant pressure in the main gas flue at all times of 1.8 inches of water pressure) a pyrometer for gas temperatures which is of the recording type, also an indicating thermometer for the air supply temperature, and pressure gauges for steam and air. The mechanical double bell coal feed was operated by a hand control, holding the fire at a constant level. The operation was under perfect control, so that no hand poking was done. It was felt that complete equipment of automatic controls would have regularized the operations of the producer still more, resulting in a gas of practically constant quality.

A controlled condition laid down by the mill management was that the normal furnace operation could not be modified in any way during the testing of this coal. It was not permitted, for instance, to slow down one of the other producers to make a high capacity test of the slack coal gasification. Nevertheless, on account of variations in the number of furnaces used, it was possible to operate through a range of from 1585 lbs. of coal hourly up to 5985 lbs. per hour.

The character of the coal is shown by the analysis in Table V.

An interesting detail of the fuel feed is the amount of coal delivered into the producer for each drop of the discharge bell of the feed. Coal is charged into the producer every 33.34 seconds, during which time the combustion zone has traveled through a rotation of 32.7°. The coal falls on to the fuel bed in the form of a hollow circle whose
By the time the producer body and fuel bed have traveled through an angle of about 200° from the feed, passing in the meantime under the gas offtake, the volatiles have been distilled off into the gas as carbon monoxide. Also the high fusion temperature of the ash, calling for a relatively low humidification of the air, would contribute a small amount of hydrogen. These circumstances are reflected in the gas analysis, which averaged:

<table>
<thead>
<tr>
<th>CO</th>
<th>CO₂</th>
<th>CH₄</th>
<th>H₂</th>
<th>N₂</th>
<th>H₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.2</td>
<td>7.1</td>
<td>2.5</td>
<td>0.15</td>
<td>13.75</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Total | 60.4

Gross calorific value at 60° F. | 148.5 B.t.u.

The pressures were:

- Air at blower outlet | 6.5 in.
- Gas at producer outlet | 1.8 in.
- Net effective air delivery pressure | 4.7 in.

While the flue dust was not weighed, the discharge from the dust catcher was noted and careful visual inspection made of the dust from this producer and the other five which were running on selected and quite clean run of mine coal. The flue dust for both fuels was exceedingly small in amount.

Curves plotted from the results of the test are interesting, indicating that increased gasification rates are accompanied by an increased quantity of carbon monoxide, a decrease in carbon dioxide, and an increase in the CO/CO₂ ratio as predicted by the curves of diagrams showing the gas characteristics.

As this is the first published report, that the writer is aware of, of the gasification of a low volatile coal of such fineness, it is believed to be of interest to those desirous of seeing more extended use of low grade fuels as a step in the conservation of the nation’s resources.

The notable increase in gas producer capacity, even though using larger amounts than previously of slack and other low grade coals within the past three or four years, is largely due to the appreciation on the part of the owner of the possibilities made available by the complete mechanization of the producer. Mechanical functioning is now carried even to the maintaining of a desirable porosity of that portion of the ash zone through which the air supply rises to the gasification zone, as well as to the increasing ash elimination, thereby securing an adequate air delivery with a very moderate air pressure at the turbo-blower exit. Another benefit thus secured is the adaptability of the modern gas producer to the application of instrumental control of operation and of input and output based upon

Table V

<table>
<thead>
<tr>
<th>Make of Gas</th>
<th>Producer</th>
<th>Low volatile, slack, coking bituminous coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal per ton of steel</td>
<td>76.3 lbs. per sq. ft. per hr.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plant</th>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal per ton of steel</td>
<td>1914</td>
<td>600</td>
<td>94</td>
<td>548</td>
<td>477</td>
<td>412</td>
<td>429</td>
<td>428</td>
</tr>
<tr>
<td>Producer area per ton of steel per heat</td>
<td>1915</td>
<td>3.6</td>
<td>0.82</td>
<td>1.5</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Producer area per sq. ft. hearth area</td>
<td>0.72</td>
<td>0.33</td>
<td>0.6</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
gas pressure and temperature conditions desired in the furnace.

Kinney and McDermott presented to the Institute some eight and a half years ago their notable paper on “Open-Hearth Efficiency.” The basis of their paper was typical practice at the South Works of (Continued on page 1154)

Lectures on Principles of Metallurgy

DURING the Fall a course of lectures will be delivered at the Frick Training School, Pittsburgh, Pa., by prominent metallurgists for the benefit of young men who have not had the advantages of a technical education. Although these lectures will cover elementary metallurgy, the range of subjects will be so broad that workers in all metal industries may attend the course with profit. The following is a list of the subjects that will be discussed by the several lecturers:

Pyrometry, fuels and combustion, refractories and furnaces, fluxes and slags, manufacture of pig iron, steel and wrought iron; structure of metals and alloys, basic principles of heat treatment, forging, stamping and drawing; case carburizing and nitriding, special alloy steels, castings, and testing of metals.

A tentative list of lecturers follows: Dr. C. W. Herty, U. S. Bureau of Mines; Prof. E. G. Hill, Lukens Steel Company; Mr. J. S. McDowell, Harbison-Walker Refractories Company; Dr. S. L. Goodale, University of Pittsburgh; Dr. V. N. Krivobok, Carnegie Institute of Technology; Mr. N. I. Stotz, Braburn Steel Corporation; Mr. J. A. Succop, Heppenstall Company; Dr. J. T. Aston, Carnegie Institute of Technology, and Mr. R. L. Templin, Aluminum Company of America.

The committee hopes to keep the fee for the course as low as $10.00. This will be possible if the enrollment is what it should be.

Mammoth Floating Lock-Gate Lifter

THE gigantic floating crane shown in the illustration—one of the most interesting and outstanding pieces of equipment for the new Welland ship canal—is for emergency use in removing and replacing the huge lock gates should they be damaged or in need of repairs.

It is a self-contained unit independent of other apparatus except that it is not self-propelling. The steel pontoon is 90 ft. long, 66 ft. wide and 26 ft. deep; its power plant consists of an oil-burning scotch marine boiler, 300 hp.; forced lubrication engine direct connected to a 200 kw., 230 volt d.c. generator at 400 r.p.m. The two towers which stand 72 ft. above the deck consist of trussed A frame bents placed parallel to and at either side of the longitudinal center line of the pontoon with their vertical front legs placed at the forward end.

A horizontal girder having guide wheels which engage the main columns so that the girder is free to move vertically but not horizontally is employed to maintain transverse stability. The lifting ropes pass through this stabilizing girder and the girder is lifted on projections of the hangar forgings which enter sockets in the girder.

Four separate main gate hoists of 125 tons capacity, spaced to suit the gate leaf lifting eyes, are driven by 50 hp. motors connected by reduction gearing to screws 9½ in. diameter and about 54 ft. long, the controls being such that the four hoisting units are locked together to operate as a single hoist unit of 500 tons capacity after the load has been properly equalized. The nuts on the screws are attached to the sheave carriages which are drawn from the forward to the after part of the pontoon by the rotation of the screws. A movement of 45 ft. on the sheave carriages raises a gate leaf 90 ft.

To prevent overbalancing of the pontoon during lifting operations, a unique system of shifting water ballast is used with powerful electrically driven centrifugal pumps to transfer water from forward to aft ballast tanks as required, with similar provision for athwartship trim.

This machine is also equipped with a 25-ton auxiliary derrick with a 105 ft. swinging boom for handling the discharge valves of the various locks.

The control room is built on top of the deckhouse amidships, and contains remote controls for the hoisting machinery, ballast pumps and ballast line manifolds, as well as the valves for controlling the fluid equalizing system, the gauges for indicating cylinder pressures and telegauges showing the amount of water in the various ballast tanks. (Continued on page 1125)
Progress in Steam Distribution

The piping system is the vital connecting link between the boilers and the steam-using equipment and should receive major consideration.

By C. A. CARPENTER

The rapid development of electrified operations has radically changed the duties of the steam engineering department in steel mills. Only a few years ago a typical steel plant had batteries of coal fired boilers located in a building close to the engine driven rolling mills. Very little heating of miscellaneous shop buildings was attempted. Practically all steam passed to jet or barometric condensers, to the sewers as condensate, or was exhausted by stacks.

Partially treated raw water entered open heaters where exhaust in excessive amounts warmed the water before admission to the boilers. Steam pressures were relatively low and little, if any, superheating was attempted.

Heating of buildings was accomplished with exhaust steam by means of pipe coils or blower and duct systems. Occasionally live steam at nearly boiler pressure was used in heating systems with little or no attempt to return condensate to the boilers.

Modern practice calls for boiler houses approaching the central station type. Pressures above 400 lb. per sq. in. are common and superheat is general. By-product fuels are used—principally blast furnace gas previously wasted. Power is generated in modern turbine stations. Transmission to the mill motors may involve long distances. Thanks to the unit heater which has permitted heating industrial buildings at reasonable cost, many more steel mill buildings are adequately heated than ever before.

Steam continues in use with gas producers, pickling tanks and other process operations. Steel mill steam engineering today requires very broad technical training and wide experience. In the first place, central station boiler practice must be thoroughly understood but the steel mill engineer must adapt waste fuels for his work, which involves many new complex problems. Since many mills are located near contaminated water supplies and huge quantities of water are needed by blast furnaces and other equipment, the mill engineer faces water conditions not encountered by central station operators.

Much benefit can follow a more or less detached survey of steel mill steam uses, viewing the several problems with proper perspective.

Available Fuels

First, the primary power house must be considered. What by-product fuels are available? What are they worth per 1000 B.t.u.? Can coal from captive mines compete?

Special water supplies may be available, such as more or less distant clear water streams, underground water courses available through wells, etc. Costs of delivery to points of application must be figured. Expenses for treatment and value of lower temperatures of well water must be considered.

If the main boiler house and turbine generator plant be considered by themselves, it is possible to apply all the technique of modern power plant engineering.

Secondly, it is essential to adopt sound principles in connection with steam distribution systems. It seems to the author that there is at least a slight tendency for mill engineers to rely on antiquated and obsolete methods for this important work. Just as power plant engineering has progressed rapidly during the past 10 years, so has the engineering of steam distribution. Comparable to the central power stations which have set the pace in their line, are the central district steam heating
Insulation is an important part of steam piping work. Coverings are obtainable that are low in first cost, remarkably efficient and easy to install. With an open mind, based on sound technical analysis and horse sense, a mill steam distribution system may be worked out to take steam at boiler pressure and superheat, and deliver this steam reliably and economically to various points of use at suitable pressures and temperatures.

Auxiliary apparatus may be necessary, such as, evaporators to transform high pressure, high temperature steam to lower pressure saturated steam and many small items of equipment may find use in mills. Hot water heaters served by steam are desirable in many places to furnish the large quantities of warm water required. Meters may pay for themselves in a few months by enabling accounting departments to check actual consumption of various subdivisions of the plant.

In conclusion, it may be emphasized that steam distribution in a mill should be studied as a problem by itself. Just as other phases of steel making are rapidly progressing, so also is the business and science of steam distribution. The piping system is the vital connecting link between the boilers and the steam using equipment and should receive major consideration.

Mammoth Floating Lock-Gate Lifter

(Continued from page 1123)

The man in charge directs operations from the bridge on top of towers from which point there is telephone communication to the control and engine rooms.

The accompanying photograph was taken when handling the 35 ft.-6 in. high and 44 ft.-6 in. high gate leaves, during the tests prescribed by the canal engineers for ascertaining the stability, power consumption, reliability and control of power and movable water ballast, when it was demonstrated that the ballast pumps have ample capacity to maintain zero list and trim without stopping the hoist motion or lowering motion, and that each and every piece of apparatus and control equipment functioned as planned without difficulty.

The gate-lifter was designed by The Wellman Engineering Company, Cleveland, Ohio, for the Department of Railways and Canals of Canada and built in Canada from their plans and specifications.

Preliminary Work Completed at Nizhni Tagil Steel Plant

ALL preliminary work on the construction of the Nizhni Tagil steel plant in the Urals was completed on April 1. The plant is being erected near the Visokaya mountain, whose ore deposits are twice as rich as those of Maglitnaya (to be used by the Magnitogorsk steel plant).
Distributing Steam Costs in the Plant

In which is discussed the problem of an unaccounted for balance and the consumption of steam by the power house and boiler house auxiliaries

By L. G. JONES

PART VI

The steam consumed by the power house generator turbines is a fairly simple item of calculation as compared with most other departments discussed hereinbefore. The power house contains large units whose output is accurately metered in convertible units, and whose operation is fairly constant and continuous. In the other departments many of the uses of steam are intangible, the operation may be violently fluctuating without means of output determination.

The generating equipment of most steel mill power houses consist of up-to-date steam turbines; although some plants may still utilize large reciprocating engines. Many plants may keep their engines as reserve equipment as standby to newer turbo-generators. These engines may be rarely if ever used.

Such prime movers have undergone extensive tests both by manufacturers and operating plants with fairly accurate determinations of water rates. A great amount of material on their steam consumptions has been published so that their application to existing equipment becomes a simple matter with proper corrections made for condenser operation, load, auxiliaries, and other conditions.

The plant in question has four turbo-generators, one each of the following capacities: 2,500 kw., 4,000 kw., 5,000 kw., and 10,000 kw. Steam is received at 175 lb. gage, 100 deg. F. superheat, exhausting into barometric condensers at 28 in. vacuum. Each condenser is equipped with steam driven auxiliary equipment.

Based upon normal load conditions, age of equipment, condensing temperatures, and general plant practice, the water rates shown in Table I were used in steam calculations for the power house.

Each generator has its regular output electric meters with complete daily operating records containing hourly data on all equipment. From this power plant log all figures required in calculating steam consumptions becomes readily available. At the end of the month the total power production for the month for each generator is multiplied by the basic steam charge for the given turbine.

To this total steam charge for power generator a monthly charge for power house heating is made in winter time, as taken from tables similar to those shown in this series for previous departments. This figure averages about 350,000 lb. per month in severe weather.

Boiler Auxiliaries

It is unnecessary to mention the steam consumed by boiler auxiliaries due to the fact that such consumption is charged to the other plant departments as part of the costs of steam production. As a part of the total cost of steam that we have been trying to distribute, this steam is not chargeable on the regular steam distribution report—it does not leave the boiler plant.

However, since these auxiliaries are true steam consumers, sort of necessary evils, it might be well to mention them. They receive such mention on the monthly steam distribution report, merely to show that they are in existence and to relieve the unaccounted-for volume from carrying this burden, to the discredit of the distributing engineer.

At the three boiler plants in this works all boiler auxiliaries are steam driven. These include stoker engines, fan turbines, feed water turbines, feed water plunger pumps, stoker dumps, whistles, syphons, ejectors, thawing equipment for frozen coal, ash equipment, etc. Calculations and tests have deduced a steam consumption for these auxiliaries equivalent to about 5 per cent of the steam generation of the boilers, estimated as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forced draft fans</td>
<td>3.5</td>
</tr>
<tr>
<td>Feed pumps</td>
<td>1.0</td>
</tr>
<tr>
<td>Stokers</td>
<td>0.4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5.0</strong></td>
</tr>
</tbody>
</table>
This percentage figure is used each month for the derivation of steam used by boiler auxiliaries and is subtracted from the total boiler steam production prior to distribution.

All exhaust steam from these auxiliaries is returned to the feed water heaters and recovered, along with the steam from the pump turbines and engines at the water pump house.

**Boiler Blow-down**

Another factor, although it is extraneous to plant distribution, must be considered in an endeavor to make as true an accounting for all steam produced as is possible, is the amount of water that leaves the boilers without conversion to steam. The total steam generated by the boiler plants is derived from the charts and records taken from Venturi meters located at each boiler house. These meters are located in the line between the feed pumps and the boilers. Unless correction is made for draining of boilers for cleaning, blowing down of boilers, water columns, etc.; leakage of blow-down valves; and so on; all water passing through the meters will be measured as steam regardless of whether it leaves the boilers through the steam outlets or not. A balance of the steam thus generated and that distributed to the consuming departments may show an abnormal difference—an unnecessary large amount of unaccounted-for steam.

The water blown-down each time was obtained by determining the capacity of the boiler per gage, that is, the weight of water contained in the boiler between two tricocks, about 2 in. on the water glass. This was calculated from boiler drum dimensions, although it could be determined directly, either by measuring the water to or from a cold test boiler, with corrections for temperature, etc., applied. For a practice of two blow-downs per 8 hour shift of one gage each, for each boiler on the line, as taken from the boiler log sheets, the blow-down water becomes known.

In the same way the draining of each boiler for cleaning and repairs means a definite loss of water that never becomes steam, and which if not subtracted gives higher boiler efficiencies and more steam to charge out. Leaks in the lines, pumps, blow-down valves, etc., cannot be calculated, but must be eliminated. Such losses are negligible.

With these items subtracted from the metered flow, the actual evaporation can be derived. This evaporation multiplied by the factor of evaporation gives the amount of steam that must be accounted for, and serves as the basis of cost per 1,000 lb. of steam. It is the actual output of the boilers.

---

**Table I**

<table>
<thead>
<tr>
<th>Turbine No.</th>
<th>Rated Capacity, kw.</th>
<th>Gross Steam Consumption for Complete Unit, Including All Accompanying Usages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2,500</td>
<td>22.0 lb. equiv. steam per kw.h.</td>
</tr>
<tr>
<td>2</td>
<td>4,000</td>
<td>20.2 lb. equiv. steam per kw.h.</td>
</tr>
<tr>
<td>3</td>
<td>5,000</td>
<td>19.8 lb. equiv. steam per kw.h.</td>
</tr>
<tr>
<td>4</td>
<td>10,000</td>
<td>17.9 lb. equiv. steam per kw.h.</td>
</tr>
</tbody>
</table>

**Table II—Distribution of Steam to Departmental Accounts Month of April**

<table>
<thead>
<tr>
<th>Department</th>
<th>Equivalent Steam 1000 lb.</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1 Blast furnace</td>
<td>33,650</td>
<td>8.840</td>
</tr>
<tr>
<td>No. 2 Blast furnace</td>
<td>32,520</td>
<td>8.585</td>
</tr>
<tr>
<td>Pig machine</td>
<td>2,310</td>
<td>0.600</td>
</tr>
<tr>
<td>Open hearth department</td>
<td>21,830</td>
<td>5.760</td>
</tr>
<tr>
<td>Open hearth gas producers</td>
<td>4,210</td>
<td>1.111</td>
</tr>
<tr>
<td>Blooming mill</td>
<td>42,180</td>
<td>11.110</td>
</tr>
<tr>
<td>Bloom gas producers</td>
<td>3,890</td>
<td>1.025</td>
</tr>
<tr>
<td>Billet mill</td>
<td>343</td>
<td>0.091</td>
</tr>
<tr>
<td>No. 1 Merchant mill</td>
<td>16,880</td>
<td>4.500</td>
</tr>
<tr>
<td>No. 1 Merchant gas producers</td>
<td>2,170</td>
<td>0.572</td>
</tr>
<tr>
<td>No. 2 Merchant mill</td>
<td>13,920</td>
<td>3.680</td>
</tr>
<tr>
<td>No. 2 Merchant gas producers</td>
<td>1,830</td>
<td>0.498</td>
</tr>
<tr>
<td>Bar mill</td>
<td>18,880</td>
<td>4.980</td>
</tr>
<tr>
<td>Bar mill gas producers</td>
<td>2,670</td>
<td>0.705</td>
</tr>
<tr>
<td>Pickling vats</td>
<td>3,560</td>
<td>0.939</td>
</tr>
<tr>
<td>Hydraulic pumps</td>
<td>8,150</td>
<td>2.145</td>
</tr>
<tr>
<td>Coke Plant</td>
<td>35,000</td>
<td>9.240</td>
</tr>
<tr>
<td>Air compressors</td>
<td>3,240</td>
<td>0.855</td>
</tr>
<tr>
<td>Pump Houses—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw water</td>
<td>41,310</td>
<td>10.900</td>
</tr>
<tr>
<td>Purified water</td>
<td>1,440</td>
<td>0.380</td>
</tr>
<tr>
<td>Boiler water</td>
<td>900</td>
<td>0.237</td>
</tr>
<tr>
<td>Filtration Plant—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purified water</td>
<td>500</td>
<td>0.132</td>
</tr>
<tr>
<td>Boiler water</td>
<td>450</td>
<td>0.119</td>
</tr>
<tr>
<td>Chipping department</td>
<td>144</td>
<td>0.038</td>
</tr>
<tr>
<td>Special laboratory and research</td>
<td>100</td>
<td>0.042</td>
</tr>
<tr>
<td>Chemical laboratory</td>
<td>113</td>
<td>0.030</td>
</tr>
<tr>
<td>Physical laboratory</td>
<td>110</td>
<td>0.029</td>
</tr>
<tr>
<td>Offices*</td>
<td>345</td>
<td>0.091</td>
</tr>
<tr>
<td>% of Office Steam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>310</td>
<td>89.9</td>
</tr>
<tr>
<td>Plant</td>
<td>35</td>
<td>10.1</td>
</tr>
<tr>
<td>Plant restaurant</td>
<td>113</td>
<td>0.30</td>
</tr>
<tr>
<td>Power house</td>
<td>84,300</td>
<td>22.190</td>
</tr>
<tr>
<td>Shops*</td>
<td>2,073</td>
<td>0.547</td>
</tr>
<tr>
<td>% of Shop Steam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>24</td>
<td>1.16</td>
</tr>
<tr>
<td>Bricklayers</td>
<td>40</td>
<td>1.93</td>
</tr>
<tr>
<td>Carpenter</td>
<td>96</td>
<td>4.63</td>
</tr>
<tr>
<td>Welding</td>
<td>32</td>
<td>1.54</td>
</tr>
<tr>
<td>Pipe</td>
<td>64</td>
<td>3.08</td>
</tr>
<tr>
<td>Machine</td>
<td>640</td>
<td>30.87</td>
</tr>
<tr>
<td>Roll</td>
<td>240</td>
<td>11.58</td>
</tr>
<tr>
<td>Pattern</td>
<td>60</td>
<td>2.89</td>
</tr>
<tr>
<td>Boiler</td>
<td>320</td>
<td>15.43</td>
</tr>
<tr>
<td>Tin</td>
<td>77</td>
<td>3.74</td>
</tr>
<tr>
<td>Locomotive repair</td>
<td>480</td>
<td>23.15</td>
</tr>
<tr>
<td>Distribution total</td>
<td>379,291</td>
<td>100.000</td>
</tr>
<tr>
<td>Boiler auxiliaries</td>
<td>21,562</td>
<td>5.715</td>
</tr>
<tr>
<td>Unaccounted for</td>
<td>29,479</td>
<td></td>
</tr>
</tbody>
</table>

*The individual offices and shops are separately distributed in sub-percnetages of the total charged to the offices and shops respectively, due to the smallness of the consumption and percentage, and their totals being charged to general accounts. From these totals, the separate offices and shops are charged according to their individual percentage of the total of each general charge.

The monthly steam distribution as presented is simple in itself and in its monthly preparation. The
actual values of the steam consumed are not used by the accounting department in deriving departmental costs. They are, however, of importance in obtaining engineering or production data, such as, pounds of steam per ton or other unit of product; and to compare relative operations with previous months. Probably the only steam figure that reaches the heads of the operating departments is the charge in dollars and cents. If this cost seems high in relation to comparative operations, the steam distributor has figures to prove their derivation and lead to further study of the steam consuming apparatus.

In determining departmental steam costs only the percentage figures shown in the report are used, these percentages being applied to the total costs of steam making as segregated by the cost department, from fuel, labor, water, supplies, etc., and taken from actual records.

Unaccounted-for Balance

Every distribution report has an unaccounted-for balance, and this would be true were every line supplied with meters. Probably each department has wastes or losses in proportion to its steam usage. On this assumption all unaccounted for steam, that is, the difference between known steam consumptions and gross generated steam at the boilers, can be disregarded, except insofar as this quantity becomes excessive. Such a tendency would indicate a need for the revision of distribution basic data; or a check on the evaporation at the boiler house as compared with fuel consumption, for water losses, and so on. Resetting of valves on large steam prime movers may be found necessary to reduce their consumption to the basic adopted water rates, which may have been temporarily exceeded. Addition of steam consumers or changes not taken cognizance of in the making up of the report may be found. The unaccounted for steam should be kept below 10 per cent of boiler steam production.

Some steam engineers use their own judgment in balancing their steam distribution totals against the boiler output, placing charges against larger units, such as the power house, blooming mill, or such; but this leads to erroneous water rates on equipment generally maintained efficiently, and causes them to bear an unnecessary burden. With the method presented unaccounted-for steam is automatically taken care of in the percentage distribution of total boiler costs.

Boiler house economy conditions are tabulated in a separate report, which contains evaporation and fuel figures, boiler operations, etc. In order to complete the monthly routing steam data that is compiled as final reports, these will be discussed in the next section of this series.

It might be well, however, to exemplify some of the check tests made on larger prime movers for calculating steam consumptions (see Table III). Indicator cards, both single and continuous, were taken on a tandem compound mill engine, 32 in. by 56 in. x 60 in., flywheel type, Corliss valve gear, operating at constant speed, exhausting into a barometric condenser. The mill was rolling 4 in. by 4 in. billets into 34 in. rounds, with the steel temperature rather low, putting a good load on the engine in the rather large reduction of area or elongation under these conditions.

The steam consumption of the engine was calculated by the standard formula

\[
Steam = \frac{13,750 \times (bw - cw')}{p}
\]

(Carpenter-Diederich)

The point of release of the high pressure cylinder was used for calculations. The indicator card water rate calculated to be 17.25 lb. of steam per indicated horsepower, neglecting cylinder condensations. This condensation was calculated by Heck's formula for cylinder condensation (Kent, p. 1056; where all terms are explained).

\[
\text{Per cent of total steam} = \frac{C}{3} \sqrt{\frac{s}{N} \frac{T}{p}}
\]

This percentage of condensation was found to be 18.3 per cent of the indicated steam, bringing the total steam consumption per I.H.P. to 21.1 lb., or an equivalent evaporation of 23.84 lb.

This mill was rolling at the rate of 70 billets per hour or 17.2 gross tons, producing a load of 2,352 I.H.P. on the engine in doing so, or 136.6 I.H.P.hrs. per gross ton of billets. At the rate of 23.84 lb. of equivalent steam per I.H.P., the steam rate was

(Continued on page 1142)

### Table III—Indicator Card Data

<table>
<thead>
<tr>
<th>Data</th>
<th>Units</th>
<th>High Pressure</th>
<th>Low Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of card</td>
<td>Sq. In.</td>
<td>Head End</td>
<td>3.07</td>
</tr>
<tr>
<td>Length of card</td>
<td>Inches</td>
<td>Crank End</td>
<td>3.20</td>
</tr>
<tr>
<td>Average Height</td>
<td>Inches</td>
<td>Head End</td>
<td>0.960</td>
</tr>
<tr>
<td>Spring</td>
<td>Lbs.</td>
<td>Head End</td>
<td>100</td>
</tr>
<tr>
<td>M. E. P.</td>
<td>Lbs.</td>
<td>End</td>
<td>96.0</td>
</tr>
<tr>
<td>Net piston area</td>
<td>Sq. In.</td>
<td>Crank End</td>
<td>804.25</td>
</tr>
<tr>
<td>Stroke</td>
<td>Feet</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Speed</td>
<td>R.P.M.</td>
<td></td>
<td>82</td>
</tr>
<tr>
<td>Ind. H.P.</td>
<td>I.H.P.</td>
<td></td>
<td>960</td>
</tr>
</tbody>
</table>

Engine Conditions: Steam pressure, 180 lb. gage; superheat, 120 deg. F.; condenser vacuum, 26.3 in. Hg.; hot well temperature, 95 deg. F.; cut-off on high pressure cylinder, 35 per cent; low pressure, cylinder, none.
Improved Bar Straightener—Motor Driven Ram Adjustment

A RECENT development of the Aetna-Standard Engineering Company, Youngstown, Ohio, is the bar straightening machine or bulldozer shown in the accompanying photograph. It is one of the largest machines of its kind and is of especial interest to manufacturers having round or square billets that must be made commercially straight.

Round or square billets from 3 in. to 12 in. in size are handled to the machine by either roller tables or by hand, depending on the size of the billet being straightened. A means of turning the billet in the machine has been provided for, through the use of a roller lifting device which is operated by an air-cylinder.

The pusher head or ram is made adjustable to suit the various sizes to be handled and also to allow for various degrees of “crookedness” in the billets themselves. The adjusting mechanism, instead of being operated by a handwheel as is usually the case, is in this instance driven by a small motor, which is connected to the adjusting nut by means of gears and a flexible coupling. In order that the operator may set this adjustment device at the proper position a graduated dial is mounted on each side of the housing. This makes for ease of adjustment as the machine may be set for any size billet, either at the machine itself or from a remote control.

The main drive gear and pinion have double-helical teeth while the secondary gears are spur toothed. The crank pin for motivating the ram as well as the splash system while all other moving parts are lubricated by means of a high-pressure grease system.

The extreme simplicity of design used in this machine as well as the fact that all parts are extremely accessible make it a very desirable addition to any plant.

Auto Floor Manipulator

THE accompanying illustration shows a Brosius Auto Floor Manipulator, designed and built by Edgar E. Brosius, Inc., Pittsburgh, Pa., for manipulating forgings under a steam hammer. The machine is a modification of the well-known Brosius Auto Floor Charging Machine in use for several years in the United States and abroad.

Since an articulate peel is used, with two sets of shock absorbing springs, no shock for the hammer blow is transmitted to the machine. All shock is taken up in the peel and pieces are manipulated under the hammer with speed and accuracy, doing away with the regular hammer crew.

The machine shown is handling axle blanks weighing 1600 pounds and will easily make as many axles in a day as the hand crew did at their best. The job of operating the manipulator is an easy one and it does away with all hand labor around the hammer.

The manipulator is self-contained and requires no tracks or overhead runways. Its movement is not restricted to any definite path, and no provision, aside from a good floor on which to operate, is necessary for its installation.

The Auto Floor Machine is also built for handling slabs, billets, ingots, etc., between heating furnaces and mill, and for serving open hearth furnaces, electric furnaces, cupolas, etc.
Coal Pulverizer

The emphasis placed on the economical use of pulverized coal by small and medium sized industrial boiler plants has resulted in the need of a coal pulverizer that has the same relative performance and reliability demanded of higher capacity pulverizers in the larger stations. To meet these requirements the Fuller Lehigh Company, 85 Liberty Street, New York City, has developed and placed on the market a new pulverizer known as Type C.

The design of this mill includes the ball and grinding ring principles of pulverizing. This is an especially desirable feature in mills of small capacities because by its use fineness of the pulverized coal is not affected by wear of the grinding parts. The coal is pulverized by large-diameter balls grinding under pressure between upper and lower grinding rings. The pressure between the grinding parts is applied and maintained by a heavy steel spring mounted in the top section of the mill.

The mill also is well suited for pulverizing coals of different grindabilities since the grinding pressure can be adjusted to suit the hardness of the coal.

The balls in the Type C pulverizer wear spherically and uniformly, and together with the grinding rings have long life, since these parts are unusually resistant to abrasion and have no metal-to-metal contact.

Wet coal can be pulverized in the Type C Pulverizer when preheated-air is used for separation of the fines. Since the coal is dried by the hot air as it flows through the mill, it is unnecessary to install separate drying equipment for this purpose.

The Type C pulverizer is easy to control for the mill runs at a constant speed and requires only a few adjustments whenever the steaming capacity of a boiler is changed. A change in capacity is made by simply varying the rate of the coal-feed to the mill and the mill responds quickly to such changes, but not so quickly that undesirable fluctuations occur at the pulverized-coal burner.

Raw coal, crushed to pass through a %-inch ring, is fed to the mill from an overhead bunker by means of a table-type feeder. The coal, after entering the mill through the coal-inlet spout, drops into the path of the grinding balls where it is pulverized.

Tramp iron or other foreign material that may pass into the mill with the coal is at once rejected outward from the grinding zone by the grinding balls and can be removed through the large access door in the top section.

The air for separating the coarse particles of coal from the fines enters the mill under pressure through the air inlet in the intermediate section. The air currents pass through this section into the annular passage between the stationary grinding-ring and the driving-yoke, and, as they flow upward, they pick up the particles of finely pulverized coal and remove them from the grinding zone.

The pulverized coal and air streams continue their upward movement whence they are discharged through ports in the rotating spider. An overhang

Combustion Steam Generator

Combustion Engineering Corporation, 200 Madison Avenue, New York, is now offering the combustion steam generator, a standard steam generating unit built in various sizes and providing a wide range of capacities at any desired conditions of steam temperature and pressure. Detail designs have been completed for eight sizes with capacities ranging from 70,000 to 400,000 lb. of steam per hour, from and at 212 deg. F.

As shown in the accompanying illustration, this design combines in one unit all the elements required for fuel-burning, steam generation and superheating, heat recovery and ash disposal. Those familiar with the development of pulverized-fuel-firing and the history of steam generating practice will note that there are no novel or radical departures from fundamentals, but rather that the design represents a highly compact and simple arrangement of long and well-established elements. They
will also note the apparent absence of the maze of pipes, headers, etc., exterior to the boiler casing, with which such construction has become associated in their minds. These pipes and headers essential for completing the circulating system of water walls are located entirely within the casing, where, in addition to performing their normal function as circulators, also serve as highly effective heat absorbing surfaces.

A point of particular interest is the entire absence of openings through the casing. Such openings are ordinarily required for the ingress and egress of wall tubes and headers. They are never perfectly sealed and consequently permit the discharge of dust during soot blowing operations, as well as the inflow of air during normal operation. The combustion steam generator casing is air-tight and dust-tight throughout.

All four walls of the furnace are water-cooled, each wall being composed of a solid row of tubes with only sufficient space between them for construction requirements. The water-wall feeder and delivery tubes, at the bottom and top of the furnace respectively, complete the heating surface of the furnace proper nearly all of which is exposed to radiant as well as convection heat.

The result of this arrangement of wall tubes and circulators is a furnace built completely of water tubes to the exclusion of exposed refractories and having the maximum attainable quantity of contained water with provision for the highest possible freedom of circulation.

This type of furnace is perfectly adapted to the type of firing used, i.e., the corner-tangential system which produces intense turbulence with extreme rapidity of combustion and correspondingly high temperatures, these high temperatures being the result (not the cause) of the high rates of combustion.

Another feature of interest is the superheater bypass damper which affords a unique and much needed means of controlling superheat temperature. Adequate space is provided for the superheater, which is so located in the assembly as to permit of simple supports and a degree of accessibility unusual in boiler construction.

The first unit of this new design to be installed in America has now been in operation for several months in the plant of a leading industrial company. In overall results and ease and dependableness of operation, its performance has set an exceptionally high standard.

**Ball Transfer for Handling Materials**

A NEW type of handling equipment, known as the Mathews ball transfer, is designed to accommodate the movement of any object having smooth hard surfaces in any direction on a horizontal plane. Its application is not confined to any particular type of work or to any one industry.

This modern conveying device consists of a large hardened steel ball which rotates on a series of smaller balls held in a cupped base. A dust and dirt cap rests on the ball, being held in position by a spring retainer. Its knife edge contact deflects foreign substances which might clog the supporting balls if admitted to the base.
Two models are available, one for mounting in series on a table of flat surface support, and one for mounting on pipe supports. When mounted in groups on a heavy structural support, Mathews Ball Transfers provide a very effective means of moving heavy shapes to and from shears, for conveying boxes to and from a line of roller or power conveyors, for handling heavy cores or molds when these loads are placed on smooth bottom plates. The ball table, as it might be termed when a group of the ball transfers are used, also serves as an efficient turntable for rotating heavy work in machining operations. When mounted on pipe supports fixed in the floor in any desired arrangement, these transfers provide an ideal bed on which large plates and other materials of this sort can be moved.

The Type 200 Mathews Ball Transfer is constructed with a 4-inch diameter round base, with four holes for mounting. Type 201 has a 3-inch square base with four holes for mounting. Type 202 has a threaded coupling base for 2-inch standard pipe. These three types have a load rating of 200 pounds each, and are equipped with a 1/2-inch diameter hardened steel ball supported on one hundred and five 3/16-inch diameter hardened steel balls carried in a heavy hardened steel base.

The Type 500 Mathews Ball Transfer is similar to the Type 202, but of heavier proportions throughout, and has a load rating of 500 pounds each. The base is of drop forged steel, threaded for 2-inch standard pipe. A 2-inch diameter hardened steel ball is supported on sixty-five 5/16-inch diameter hardened steel balls.

The Mathews Ball Transfer was designed and is constructed by Mathews Conveyor Company, Ellwood City, Pa. A new folder which illustrates and describes this unique development will be sent by the manufacturer by request.

Aluminum Alloy Boom

THE Marion Steam Shovel Company, Marion, Ohio, has just shipped to one of the large Mississippi contractors, the McWilliams Dredging Company, of Chicago, Illinois, an aluminum alloy boom for use on one of its Marion Type 5241 giant dragline excavators—the first ever built for a large dragline. Aluminum alloy, which weighs about one-third as much as steel, permits this boom to be built with a weight less than one-half that of a steel boom of equivalent length and strength.

Although the cost of aluminum alloy is much greater than that of steel, the increased cost of an excavator equipped with a boom of that material is of little amount when one takes into consideration the three distinct advantages possible.

On certain of the Mississippi River work the question of the working weight of the excavator is of prime importance. For such work the excavator with an aluminum alloy boom of a given length and bucket capacity can be built with a working weight much less than with all steel construction. This allows the excavator to be used where the floor or footing is so unstable as to preclude the use of a machine of all steel construction.

In other parts of the work the range or reach of the excavator is the principal factor. Here the excavator with aluminum alloy boom can be built of a given working weight and bucket capacity, but with much greater range than with a boom of all steel construction. This is of great value, as the handling of material is lessened to a great extent.

In still other portions of the work the yardage capacity of the excavator is of greater importance than either of the above. In this case the excavator with aluminum alloy boom can be built with the same working weight and range as one with the steel boom, but having much larger bucket capacity and therefore capable of greater yardage without any increase in the gross power or labor expense.

The weight of the steel boom is such that for ease in handling, shipping and assembling in the field, it must be made in three sections, while the aluminum boom can be made in two.

Gas Electric Locomotive Dump Car

By R. H. Dalgleish, Jr.,

Transportation Division
Westinghouse Electric and Manufacturing Company

A DEVELOPMENT unique in conception and design has recently been perfected by The Differential Steel Car Company, Findlay, Ohio. Essentially it consists of a locomotive chassis with a dump body mounted on it. It is a self-contained unit carrying its own power plant. This locomotive is intended for service in open pit mining and quarry work and in industrial plants. In many operations of this type, steam equipment is uneconomical because of high maintenance and operating costs. Often electric power is not available or is costly, or the cost of the installation of an electric distribution system is not justifiable.

It is desirable to have an economical self-propelled vehicle for temporary operations such as stripping the over-burden from an ore body and other similar operations where it would not be desirable to set poles and string trolley wire or to provide sub-station facilities. Around foundries, mills and industrial plants, it is also advantageous to have such a vehicle which can be used for switching loaded and empty cars and can also be used for the disposal of waste. Operations of this kind and all small operations will find this vehicle advantageous as the gasoline engine is well understood by the average man and the simplicity of the electrical equipment combined with it will not require particularly skilled help. In operations of this kind where the service required is intermittent, the economy of this vehicle is apparent as the fuel consumption stops the minute the switch is cut off.

This gas-electric locomotive has a 24-yard level load dump body on it. The sturdy truck and frame
construction has all the features of a locomotive and the dump body allows for a payload to be hauled on the locomotive as well as the trailer cars. The locomotive alone may be used for stock piling and a variable tractive effort may be obtained by varying the load on the body. It is not necessary under the light load conditions to carry the maximum weight on the locomotive.

The equipment weighs 45 tons light and 80 tons loaded. The air brake equipment is Westinghouse combination straight and automatic with Gardner Denver 60 ft. compressor belted from each engine, giving an air capacity of 120 cu. ft. per minute. Truck center distance 29 ft., wheel center 5 ft. 6 in.

The power plant is mounted between the center sills and is thus protected in every way from falling material. The radiators are of the sectional type mounted along the side sills and blown by centrifugal fans through holes in the side sills, thus they are protected from damage.

Essentially this particular equipment consists of a double power plant equipment mounted on a sling between the sills, consisting of 2 Buda type JH-6 gasoline engines, each rated 155 hp. at 1200 rpm., two generators, Westinghouse type 180-D-5, four type 908-RH motors and the necessary control apparatus for convenient and efficient operation of the locomotive.

The electrical equipment comprises the apparatus necessary for the transmission of power from internal combustion engines, which are the source of power in this type of locomotive, to the driving wheels. It also provides a means of efficiently controlling the speed, tractive effort and acceleration of the locomotive.

Operation of this locomotive is extremely simple and convenient, and the scheme of control provides a maximum tractive effort during the first part of the acceleration at low speed, and yet provides also for a higher locomotive speed when high tractive effort is no longer required. All starting and stopping of engines, and starting and stopping, reversing, accelerating and dumping of the locomotive is done from the operator's station.

**Electric Welding Unit**

The completion of a new electric welding unit which greatly increases the range of steel tubing produced by the Johnson process is announced by officials of Steel & Tubes, Inc., of Cleveland, a subsidiary of Republic Steel Corporation.

After several years of experimental work, it is reported, a machine has been developed which will weld tubing of much heavier wall thickness than has heretofore been possible, up to 5 in. in diameter. Sizes formerly direct-welded in this manner ranged from No. 26 to No. 11 gage. The new unit electrically welds tubing up to 3/4 in. in thickness, increasing the wall range to No. 3 gage, all intermediate gages being included.

**Improved Galvanizing Drives Eliminate Chatter**

**INTERMITTENT** action of galvanizing finishing rolls due to chatter and backlash inherent in the selective gear type galvanizing drive has in the past interfered with uniform coating. This tendency to coat unevenly due to interrupted action of the finishing rolls has been particularly noticeable when depositing heavy coatings at low speed.

Within the past year improvements in galvanizing drive design have entirely eliminated chatter in the final coating rolls at all speeds as well as increased the selectivity of the speed compensating transmission which permits speed adjustments following finishing roll redressing.

In a typical drive of the old type a 15-hp. motor is connected through spur gearing to the main drive shaft. The end of this shaft nearest the galvanizing rig is provided with a bevel gear which engages with the center galvanizing roll drive gears. Through intermediate bevel gears (powered by the drive shaft) right angle drives are provided to operate worm reductions for driving the flux rolls and the final finishing rolls. The slow speed shaft of the finishing roll drive worm reducer is connected by spur gears to the finishing roll drive jack shaft. The purpose of the jack shaft is to provide a sliding way for the pinion and idler which may be optionally meshed with a series of stepped spur gears attached to the finishing roll drive shaft. Through these stepped spur gears speed variations may be effected to compensate for varying diameters of the final or finishing rolls as these rolls are redressed.
However, the construction of this type drive, permitting as it does, play and backlash with resultant chatter and intermittent action through the succession of spur gears comprising the final drive, left unsolved a serious galvanizing difficulty, namely: smooth uninterrupted action of the final or finishing rolls.

To overcome the inherent disadvantages of the old type drive without losing the benefits of speed regulation, the two-motor drive shown in the illustration has been developed. In this apparatus one motor is directly connected through a flexible coupling to a worm drive reducer, the low speed shaft of which is extended to drive the final or finishing rolls.

By eliminating all change gearing between motor and finishing roll drive, backlash resulting in intermittent action of the final coating rolls is entirely eliminated. To provide the necessary speed changes a second motor is directly connected through a worm reducer and a bevel gear transmission to drive the center and flux rolls of the galvanizing machine in much the same manner as those in the old type, and speed regulation of the flux and center rolls with the finishing rolls is effected by special electrical control, permitting speed adjustments between the motors in much finer increments than is possible in the step gear type transmission, while the control prevents any deviation from the speed setting when it is once established. Thus, the two-motor galvanizing drive, while providing smooth uninterrupted final roll action through a final worm and worm wheel drive, also offers closer speed regulation than is possible with the step cone type of transmission.

In plans where power conditions are not favorable to the installation of the two-motor drive synchronized control, a single motor drive having all the advantages of the two-motor drive has been developed.

In this arrangement a 15-hp. motor having coupling extensions on both ends of the armature shaft is located between two worm type reduction units, one of which drives the final finishing rolls in the same manner as that employed in the double motor drive. The other end of the armature shaft is directly connected to a second worm type reducer, the low speed shaft of which connects to a Link Belt positive infinitely variable speed transmission. The driven shaft of the variable speed transmission is directly connected to a bevel gear reduction unit, the extended shaft of which drives the center rolls while an angular extension shaft drives a third worm gear reducer which in turn drives the entering or flux rolls.

Speed adjustment for various diameters of the finishing rolls is effected through the infinite variations made possible by the Link Belt variable speed transmission, that is—as the final galvanizing rolls are reduced in diameter, a corresponding reduction in the speed of the center and flux rolls is effected through the variable speed transmission unit.
Safety Engineer Promoted

William Conibear, Ishpeming, Mich., in charge of safety work in the mines of Cleveland-Cliffs Iron Company, Cleveland, has been promoted to assistant superintendent.

The Attitude of the Public Toward Safety

W. D. Ryan in a recent Bureau of Mines information circular writes the following:

“Accident prevention is not prominent in the public mind because it does not have the dramatic appeal of a purely political question. We receive our impressions of it from single instances and isolated occurrences; and only the student or the searcher for truth knows of its human horror or its economic importance as a whole. It is difficult to focus attention upon it. The attitude of the average individual toward the problem of accident prevention is somewhat similar to his attitude toward death; he is willing to admit, at any time, if he is pressed to do so, that death may be very near, but he thinks and acts always as if it were very remote. Thus any particular individual may not have suffered directly or indirectly from any particular accident. His acquaintance with the subject as a whole may come from reading an account in his daily paper, and he probably views the matter in an impersonal light. He is utterly unconscious of his own nearness to it. He probably does not realize that the cumulative cost of all the accidents happening in the country every year is tremendous and that every individual, although he may never have witnessed an accident, pays his share of the overwhelming price.”

Large Reduction in Accidents

The Pittsburgh Forgings Company, at Coraopolis, Pa., with 400 employees, experienced 38 lost-time accidents in 1930 as against 147 in 1929.

Compensation Referees Confer in New York

A conference of all the referees attached to the Workmen’s Compensation Division of the State Department of Labor was held recently at the New York offices of the Labor Department.

The conference was called, according to an announcement of the Labor Department, for the purpose of discussing various problems involved in new legislation, procedure and court decisions in workmen’s compensation cases. The State Industrial Commissioner, Francis Perkins, presided.

The chairman of the industrial Board, Richard J. Cullen, presented a digest of new legislation. Questions of the effect on workers of wage rates, the 2, 3, and 4 day week, and reduced earnings due to the depression were discussed.

Consideration was given to conduct of hearings and procedure in compensation cases and medical bills in third party cases.

Guaranteed Luck!

Popular belief has it that if one is successful in lodging a stone on top of a stone elephant’s back in three attempts he will have good luck. The elephant is located at the Ming Tombs near Nanking, China.

At Midvale a similar superstition persists among some of our men. They have a subconscious feeling that if they chip, or grind, or turn tough alloy steels, or pour babbitt once—with out goggles and get away with it, they will have good luck all the time. Accordingly the next time they have just a wee little bit to chip or turn, they leave off the goggles. And an accident statistic is created.

You could toss a hundred stones on the elephant’s back, but if you persist in being careless and thoughtless about your work, all the mythical luck in the world won’t save you from an enforced sojourn in a local medical institution.

TRADE NOTES

The Blaw-Knox Company wishes to announce that Mr. Nicholas Gerten, formerly vice president of the Blaw-Knox International Corporation of New York City, has been elected president of that organization. Mr. Gerten joined the Blaw-Knox organization in January, 1928, as sales manager of the Blaw-Knox International Corporation. He was formerly an engineer in the technical department of the Mitsubishi Company in New York and prior to that was with the Allied Machinery Company, a subsidiary of the American International Corporation, engaged in the export of American machinery.

F. F. Elliott has been appointed mill and foundry general superintendent of the Westinghouse Electric and Manufacturing Company, it is announced by J. M. Hipple, works manager.

In his new position Mr. Elliott will have general charge of the brass foundry, copper mill and Trafford Foundry operations. The works manager also announces that H. F. Seifert has been appointed superintendent of the brass foundry and copper mill; C. R. Stevens named purchasing engineer of the purchasing department, and that J. R. Thompson will continue as superintendent of the Trafford Foundry and Pattern Shop.

Ten engineers of Arthur G. McKee & Company, engineers and contractors, Cleveland, recently sailed from New York for Russia where the firm is designing and supervising the construction of a large iron and steel plant for the Soviet Government.

The new plant is located at Magnitogorsk in the Ural Mountains, and when completed will be one of the largest steel works in the world. The contingent of engineers who will form the McKee staff now in Russia are as follows:

George Moran, limestone erection plant; Niels Yde Anderson, chief designing engineer; Elmer C. Scoville, specification engineer; Robert L. Willis, design power engineer; Alexander A. Grabau, blast furnace engineer; John D. Campbell, carpenter foreman; Charles W. Springer, blast furnace erection specialist; Gaylord W. Gump, carpenter and concrete foreman, blast furnace; R. A. Watson, mining engineer; J. A. Gabriel, water and canalization engineer.

The Fusion Welding Corporation, Chicago, Illinois, has appointed the Puritan Compressed Gas Corporation of Kansas City, Missouri, as distributors for the Weldite line of welding rods. The territory served by the Puritan Compressed Gas Corporation will include the State of Kansas and the western portion of Missouri.

Until recently this company has operated as the Kansas City Oxygen Gas Company, one of the old-
est companies in the welding supply business in that section of the country.

Canada Wire and Cable Company has begun operation at Montreal East, Canada, of the hot copper rod mill built by the United Engineering and Foundry Company. This mill, which will roll all types of copper rods, contains many new developments devised for the industry by United engineers. These improvements were designed to facilitate production and render possible operating economies.

United Engineering built the mill in record time, the order having been placed in October, 1930. A number of copper mill installations have been made in the United States and other countries by United Engineering and Foundry Company in recent years.

The Beardsley & Piper Company, 2541 North Keeler Avenue, Chicago, manufacturers of sand-slingers and foundry equipment systems, announces the acquisition of the services of Aubrey J. Grindle, who has been placed in charge of the newly organized Beardsley & Piper pulverized fuel department. Mr. Grindle will have complete charge of engineering, manufacture and sale of pulverized fuel systems sold by The Beardsley & Piper Company.

All the Cincinnati branch sales offices and warehouses of the Armstrong Cork Company, manufacturer of linoleum, rugs, insulation materials, and all kinds of cork products, are to be consolidated at 232 West Seventh Street. This move, which brings together sales divisions that have previously maintained separate offices, was completed in July.

The divisions affected and the quarters from which each are moving are as follows: Armstrong Cork Company, Floor Sales Division, 538 Dixie Terminal Building; Armstrong Cork and Insulation Company, Insulation Sales Division, 1015 Broadway; Armstrong Cork Company, Cork Sales Division, 1017 Broadway. A recently organized sales unit of the company, known as the Temlok Dealer Sales Division, will also be located at the new office. The dealer distribution of Armstrong's Temlok, a fibreboard insulation, is handled by this division.

Six Companies, Inc., contractors, who will build the Hoover Dam, have placed orders with Ingersoll-Rand Company for all air compressor and rock drilling equipment that will be required for this record breaking five-year project.

The stationary air plant will consist of a battery of large Class "PRE" type direct-connected, electric-driven compressors having a combined output of 25,000 cu. ft. per minute.

These compressors will supply air for driving the four diversion tunnels that will carry the waters of the Colorado River through the canyon walls around the damsite while the dam proper is being built. Work will start immediately upon these tunnels and it is expected that they will be finished within 18 months.
The Otis Steel Company has placed an order with the Aetna Standard Engineering Company, Youngstown, Ohio, for a continuous pickler to be installed in connection with the new continuous strip mill being built at the Riverside works of the company. The amount involved in the order is $100,000.

In addition to established branch offices in New York, Pittsburgh, Chicago and Los Angeles, the Manganese Steel Forge Company, Richmond Street and Castor Avenue, Philadelphia, Pa., manufacturers of "Rol-Man" rolled and forged manganese-steel products, recently has appointed the following representatives: J. G. Logan, P. O. Box 506, Knoxville, Tenn., serving the states of Tennessee, North Carolina, South Carolina and Georgia; S. L. Morrow Engineering Company, Brown-Marx Building, Birmingham, Ala., serving the state of Alabama, Northern Mississippi and Western Florida; C. T. Patterson Company, Inc., 801 Tchoupitoulas Street, New Orleans, La., serving the state of Louisiana and Southern Mississippi, and C. H. Collier, 301 North Market Street, Dallas, Texas, serving the state of Texas.

These representatives are in a position to render engineering service and assistance in connection with standard and special applications of "Rol-Man" manganese-steel products, which include screens, liners, chutes, grizzly bars, chains, welding rods, and wear parts of various kinds.

The Globe Machine & Stamping Company of 1230 West 76th Street, Cleveland, has awarded the Austin Company, engineers and builders of that city, the contract for the modernization of a boiler house. The company manufactures steel products and automobile accessories. H. L. Gadd, president of the company, announced that the decision to revamp facilities at this time was prompted by the opportunity to obtain a more efficient plant at a time when building costs were well below the past 10-year average. An investment of $20,000 is represented in the contract.

The Semet-Solvay Engineering Corporation of New York has acquired patents and manufacturing rights relating to the Koller gas producer and the Koller mechanical grate, together with the industrial gas equipment formerly manufactured and sold by the Gas Research Company and the Smith Gas Engineering Company of Dayton, Ohio. Both of these lines will be further developed and marketed with the present Semet-Solvay Engineering gas and coke plant and welded equipment.

The Koller gas producer was originally developed by Karl Koller, of Budapest, to meet the problem of adequate gas yield when using inferior qualities of fuel. The American patent rights were acquired by the Gas Research Company and designs were developed to meet American industrial conditions. The Koller producer has been installed by coke oven, chemical, glass making, ceramic, steel and automotive industries.

Data are available showing the cost of operation of Koller producers using anthracite and bituminous coal of varying analyses. The machine is particularly well adapted to the gasification of coke breeze.

At the regular annual meeting of the directors of The Roessler & Hasslacher Chemical Company, Inc., in New York City, April 27, the following officers were elected to serve for the ensuing year: Chairman of the board, W. F. Harrington; president, Hector R. Caryeth; vice president, Mortimer J. Brown; vice president and secretary, Colby Dill; vice president, Milton Kutz; vice president, E. A. Rykenboer; treasurer, Albert Frankel; assistant treasurer, August Heuser; assistant secretary, M. D. Fisher; assistant secretary, E. A. Howard, and assistant secretary, J. Carlisle Swaim.

Several vacancies which occurred since the last annual meeting were filled. Both of the new vice presidents, Dr. E. A. Rykenboer and Dr. M. J. Brown, are from Niagara Falls and will continue to make their headquarters in that city. Colby Dill, the newly elected secretary, will make his headquarters in New York City. Dr. Brown is also vice president of the Pacific R. & H. Chemical Corporation.

Dr. Rykenboer is now also general superintendent of the company, which position includes all the duties of the former general superintendents at the individual company plants. He will be in charge of all plant operations and also general traffic, advertising, service and related company activities. He is also a director of the Niacet Chemical Corporation, Niagara Falls, N. Y.

R. & H. operates three plants, the largest of which is in Niagara Falls, N. Y. The other two plants are in Perth Amboy, N. J. and El Monte, Calif. The company's central office is at 10 East Fortieth Street, New York City, and branch sales offices are maintained in 13 strategic cities in the United States and a Mexican sales office is also maintained in Mexico City. The Roessler & Hasslacher Chemical Company, Inc., early in 1930 was merged with the E. I. du Pont de Nemours & Company, Inc.

**PUBLICATIONS**

B. & W. No. 80 Refractory Cements and Plastics is the title of a new bulletin issued by The Babcock & Wilcox Company.

This publication describes the various refractory cements and plastics manufactured by the company and outlines their uses and method of application. The bulletin is fully illustrated with photographs of installations. Various tests, such as settling, cracking, and shrinkage tests are described and illustrated.
An interesting discussion on the modern trend in refractory cements, and on the required properties of this material, is included.

Copies of this publication may be had by addressing The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

* * *

Ingersoll-Rand Company, 11 Broadway, New York, has issued Bulletin No. 3132, a 44-page booklet which illustrates and describes its line of turbo-blowers and turbo compressors. The bulletin covers the construction and operation of single-stage and multi-stage blowers for discharge pressures of one to 40 pounds and capacities of 3,000 to 100,000 cu. ft. per minute; the turbo-compressors for discharge pressures up to 110 pounds and capacities of 8,000 to 10,000 cu. ft. per minute. The booklet contains 37 illustrations, including sectional drawings, charts, blower parts, and complete units.

* * *

Copies of a new bulletin explaining automatic reversal of open-hearth furnaces and improvements it can effect in open-hearth performance, are available through the Leeds & Northrup Company of Philadelphia.

Every phase of L. & N. Automatic Reversal is covered in this new bulletin—how reversals are made automatically—what the system is—how it operates—and its advantages.

A point that will interest many steel men is the rapidly growing list of users. Since the introduction of L. & N. Automatic Temperature-Difference Reversal, leading steel plants in many different sections of the country have adopted it for their furnaces. Now, within the next few months, nineteen more open-hearth furnaces will be reversed automatically by this method. A brief description of the operation is given below:

The open hearth furnace reverses automatically whenever the two furnace ends reach a pre-determined temperature difference. Two instruments are utilized, an L. & N. Automatic Reversal Controller to operate the reversing mechanism, and an L. & N. Potentiometer Recorder to provide a chart record of furnace performance which enables the first helper to keep a close check on every heat.

Two thermocouples are used with L. & N. Reversal Controller. They are installed in corresponding locations in the regenerative system—either in the air flues or checker chambers—one on each end of the furnace. Couples for the recorder are located adjacent to the control couples and may be installed in the same protecting tube.

Large factors of safety have been incorporated in both the controller and the recorder and accuracy and reliability are maintained continuously even under severe steel making conditions.

Open-hearth operators wishing a copy of this bulletin may obtain it by addressing the Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia.

* * *

Combustion Engineering Corporation, 200 Madison Avenue, New York, has just issued catalogue SG-1, which describes the Combustion Steam Generator. This is a single unit embodying in an integral design the several elements required for the production of steam. The purpose of this design is to so coordinate the functions of the various elements as to insure maximum efficiency with minimum operating and maintenance costs.

The Combustion Steam Generator is available in eight standard sizes providing a wide range of capacities for any desired steam pressure and temperature. Pulverized fuel is introduced at the four corners of a completely water-cooled furnace and is burned with intense turbulent mixing action. The gases leaving the furnace pass through the superheater at the top of the furnace, thence through a bank of convection tubes and finally through a plate-type air preheater to the chimney. A novel arrangement provides for regulating the temperature of the superheated steam under all conditions of operation.

The catalogue is well illustrated and includes overall dimensions of the eight sizes of steam generators.

* * *

Tubular Air Heaters is the subject of a new bulletin issued by The Babcock & Wilcox Company. This publication describes a vertical tubular air heater which, the manufacturer states, is the result of considerable research and study and is simple, easily cleaned, durable and efficient with low cost and small space requirements.

The details of the air heater such as tubes, plates, casing, etc., are fully described and illustrated. Typical installation views and setting plans are shown, which demonstrate the adaptability of the air heater to various types of boilers.

Copies of this publication may be had by addressing The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

* * *

Cleveland Electric Tramrail, division of The Cleveland Crane and Engineering Company, Wickliffe, Ohio, has issued a four-page folder which concerns the movement of commodities and products in the metal industries. This publication is well illustrated with photographs of various installations for the handling of pipe, bar, and wire.

* * *

Received from The Atlas Car and Manufacturing Company, Cleveland, Ohio, is Bulletin No. 1239, which covers automatic and remote control cars manufactured by the company. Consisting of 11 pages, this publication gives a description of remote control in general and of the various types of cars designed for such control. There are numerous illustrations, some of which show interesting installations of material-handling equipment.

* * *

A four-page folder issued by the Mathews Conveyor Company, Ellwood City, Pa., describes a new type of material-handling equipment—the Mathews Ball Transfer. This equipment consists of a large
hardened steel ball which rotates on a number of smaller steel balls held in a cupped base. The publication is illustrated with photographs and diagrams of several types of the equipment, together with a large photograph of a typical sheet mill installation.

* * *

Two bulletins issued by the Mesta Machine Company, Pittsburgh, Pa., give information concerning pickling in general and the Mesta Pickling Machine in particular. In one of these bulletins—Modern Pickling—data of a practical nature concerning the pickling of tin plate, sheets, rails, and drop forgings is presented. Bulletin M—Mesta Pickling Machines—describes the construction and operation of the machine manufactured by the Mesta Company.

* * *

The Robins Conveying Belt Company, 15 Park Row, New York, N. Y., has issued Bulletin No. 80, which describes and illustrates the Robins Gyrex Screen, a flat gyrating type of separator for the efficient and continuous handling of large or small tonnages of heavy, light, wet or dry material. Illustrations consist of photographs of typical installations of the equipment and other photographs and diagrams which explain its operation.

* * *

The Westinghouse Electric and Mfg. Company announces the publication of their Circular 1915, which lists the installations of Westinghouse metal enclosed switchgear, includes photographs of some of these, and describes various types of this equipment. Circular 1899, recently published by the Westinghouse Company, describes metal enclosed switchgear in detail.

* * *

The Modern Soaking Pit, a bulletin issued by the Surface Combustion Corporation, Toledo, Ohio, presents by text and well prepared illustrations, the advantages of soaking pits equipped with Chapman-Stein recuperators and with burners of the Surface Combustion design. Miniature reproductions from blue prints show typical layouts at various plants. Copies of the bulletin may be had by writing the company.

* * *

A four-page folder handsomely printed in blue, silver and black is being distributed by The Brown Instrument Company, Philadelphia, describing the new Brown Potentiometer Pyrometer. The folder is well illustrated, showing nine of the 50 novel features claimed for this new instrument. An excellent view of the complete instrument is shown on the first page of the folder. Copies of this folder may be obtained by applying to The Brown Instrument Company, Philadelphia, Pa.

* * *

"Boiler Water Conditioning" is the title of the 16-page booklet just published by the Elgin Softener Corporation, Elgin, Ill. This discusses the various problems in the conditioning or treatment of boiler water and is profusely illustrated, showing various types of scale and sludge, corrosion and pitting, and embrittlement. A number of blue prints show various methods of gravity and pressure feeds for chemical control, the application of sludge deconcentrators to typical types of boilers, the schematic arrangement of deconcentrator and heat exchanger and the zeolite-deconcentrator combination. A copy of this publication may be obtained by writing the company.

**COMING MEETINGS**


* * *

Sept. 6-12—International Association for the Testing of Materials. First international congress to be held in Zurich, Switzerland. Information on the meeting may be obtained from C. L. Warwick, 1315 Spruce Street, Philadelphia.

* * *

Sept. 7-11—National Association of Power Engineers. Annual convention and mechanical exposition at convention hall, Kansas City, Mo. Secretary, Fred W. Raven, 417 South Dearborn Street, Chicago.

* * *

Sept. 13-15—British Institute of Metals—Annual autumn meeting at Zurich, Switzerland. Secretary, G. Shaw Scott, 36 Victoria Street, Westminster, London, S. W. 1.

* * *


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Sept. 21-26—American Society for Steel Treating. National Metal congress and exposition to be held at Commonwealth pier and Hotel Statler, Boston. Secretary, W. H. Eisenman, 7016 Euclid Avenue, Cleveland.

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Oct. 15-16—Gray Iron Institute. Fourth annual convention to be held at West Baden Springs Hotel, West Baden Springs, Ind. Secretary, J. Arthur Tuscanay, Terminal Tower, Cleveland.

* * *

Nov. 30-Dec. 5—American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Building, New York. Secretary, Calvin W. Rice, 29 West Thirty-ninth Street, New York.
News of the Plants

Eugene G. Grace, president of Bethlehem Steel Corporation, announced on July 8 that an agreement has been made for acquisition by Bethlehem of the properties and business of the Kalman Steel Company, Chicago. Acquisition is subject to the approval of the stockholders of the Kalman company.

The Kalman Steel Company is a large fabricator and distributor of reinforcing steel with warehouses in various cities in the Middle West and East. Recently it disposed of some of its eastern properties and was said to be planning to dispose of other eastern plants.

Concrete Steel Company has booked 150 tons of concrete reinforcing bars from Henry E. Baton, contractor, for two Pennsylvania State College buildings at State College, Pa.

Great Lakes Steel Corporation is about ready to start operating its new 10-in. merchant bar mill. This completes the present construction program of the company, which in little more than a year and a half has spent $25,000,000 in building open-hearth furnaces, blooming mill and two merchant bar mills at Ecorse, Mich., just below Detroit.

The city of Chicago has placed 400 tunnel car underframes, to Pressed Steel Car Company; Consolidated Coal Company, 400 mine cars, to Bethlehem Steel Corporation; Missouri Pacific, two 75-foot gas-electric rail motor cars, to St. Louis Car Company, with 400 horsepower electric plants by Electro-Motive Company; Navy department, six helium tank cars for Lakehurst, N. J., to General American Tank Corporation, previously reported as being low; Compania Chilena de Electricidad of Santiago, Chile, 30 street electric railway cars, to J. G. Brill Company, Philadelphia.

Locomotives placed: Standard Fruit Railroad Company, La Ceiba, Honduras, one 2-8-0 type locomotive to American Locomotive Company, through Equitable Equipment Company, Inc.

The Inland Steel Company has announced the addition of steel sheet piling to its line of steel products. Two sections have been developed and other sections to complete the line are to be added in the near future. The first of these sections is designated IA 15-34, weighs 42.5 pounds per foot and provides one square foot of wall for every 34 pounds of weight. The second is designated ID 16-25, a somewhat lighter section, weighing 33.3 pounds per foot and giving a square foot of wall for each 25 pounds. Both sections are featured by a particularly strong interlock.

* * *

Net earnings of Arthur G. McKee & Company, consulting and contracting engineers, Cleveland, for the first six months of 1931 were $355,415, after all charges, including reserves and federal taxes at present rates. This compares with $292,810 after similar charges for the first half of 1930. Earnings for the first half of the current year are equivalent to $4.21 on 84,410 shares of common stock outstanding, or at the annual rate of $8.42 on the same number of shares. During the first half of 1930 the net was $3.47 a share. For all of 1930 it was $6.49 and for all of 1929 it was $5.29.

* * *

Federal Abrasives Company, division of the Swann Corporation, has completed betterments and increased capacity of its abrasive plant at Anniston, Alabama. Besides an addition to the electric furnace plant, improved special equipment, the results of a long development period, has been installed in the aluminous grain finishing department.

This improved equipment is designed to regulate within close analytical limits the fracture of regular aluminous grain. With this grain variable controlled, it will be possible to fit the grain much more accurately to the particular work which it must do, when used as grain for coating, for grinding wheel manufacture, or refractories.

* * *

The United Engineering and Foundry Company has completed construction of the largest continuous plate mill in the world. It was completed within a period of one year, probably a record time for the building of such a massive piece of machinery.

It is claimed to be the largest mill installation ever made in the world for the rolling of any steel product. The mill contains the largest number of huge pieces of equipment in any existing plant.

The plates are manipulated entirely by mechanical means—the human hand never touches the rolled product. Motors of approximately 30,000 horsepower are required to operate the mill. It is possible to roll plates continuously up to 92 inches in width, and a finished ribbon of steel is possible up to 140 feet. The delivery speed of the plate mill varies from about 350 to 700 feet per minute. The total length of the mill from the soaking pits to the
MORE THAN EVER BEFORE

The use of GATHMANN INGOT MOLDS warrants your consideration.

* For more than ever before ingots of Gathmann patented design defy comparison, in yield and quality of blooms.
* We would like to prepare for you, without obligation, a modern Gathmann design for study in connection with your present ingot contour.
* Write us now so that when the order comes “full steam ahead”, you will be ready with the most efficient mold you have ever used.

THE

GATHMANN ENGINEERING COMPANY

Baltimore, Maryland

“Designers of ingot molds since 1909”

More than twenty years’ experience at your disposal.
finishing end is 2100 feet, or more than one-third of a mile.

Some of the outstanding characteristics of the installation are as follows:

- It is the heaviest plate mill in the world.
- The vertical edging mill, a component part, is the largest ever built.
- The gear drive for the roughing stand probably is the largest ever attempted. There are two gears 21 feet, eight inches in diameter, with teeth six feet in length across the face.
- Continuous operation is carried out to the greatest degree. Starting with an ingot, the steel passes through a universal slabling mill. The mill is so arranged that the finished plate can be rolled in one heat from the ingot, or by slabs being reheated in continuous slabling furnaces.
- After leaving the slabling mill, the steel goes through one stand of scale-breaking rolls, three stands of two-high roughing rolls, two vertical edging roll stands and then six stands of four-high finishing rolls. The four-high mills are all of the roller-bearing type and contain roller bearings of tremendous size.
- After passing through the continuous plate mill, the plate goes through plate leveling machines, is carried over spool-type cooling conveyors; goes to the plate turnover for inspection and finally passes through various types of shears, one type of which is considered remarkable for accuracy and method of handling. The finishing provides for the production of various types of plates.
- The entire mill is under electric control, both for controlling the thickness of the plate and the operation of the side guides and looping apparatus. The driving motors are of adjustable speed.

The projected South African Iron & Steel Corporation which is to be set up at Pretoria under the auspices of the government, is expected to start production operations in about two years, according to an announcement made by one of the corporation’s directors, received in the commerce department from Assistant Trade Commissioner DuWayne G. Clark at Johannesburg.

The various machinery is to be manufactured in England and on the continent in accordance with a pro rata scheme which should ensure the arrival of the materials in such a way that the erection of the plant can be begun as soon as the first parts arrive in Pretoria.

The first shipments from overseas are expected towards the end of the present year. One of the first units to be completed will be the coke plant, to be followed shortly by the blast furnace. The first products to be produced will be railway rails, and steel ties, although the range of products is expected to be expanded to include corrugated and flat sheet iron, wire standards, bars and sections, etc.

The United Engineering & Foundry Company has received a contract for a new cold rolling mill from the Otis Steel Company, Cleveland, Ohio. Delivery cannot be made before the fall of this year, because of the extent of business already on hand.

This contract is a supplementary order to that placed earlier in the year by Otis Steel with United Engineering, involving close to $2,000,000, under which one new hot mill and the reconstruction of a second hot mill are being undertaken for the Riverside, Cleveland, plant. The new hot mill will be a 72-in. wide continuous sheet rolling mill.

The eyes of the steel industry are likely to be focused on the production method in the cold rolling mill. Although the hot mill will finish steel in both flat and coiled form, only the coiled product will be utilized in the cold rolling mill.

Here a new and novel automatic uncoiler will be utilized to permit the steel to be passed through the stands of rolls, after which the steel will be coiled again. A new type of flying shear and a leveler will complete the product at the finishing end. Handling the steel in long lengths through the rolls will permit new economies in production.

Spang, Chalfant & Company, Pittsburgh, is understood to have plans under way for the construction of a new electric welding pipe mill at its Ambridge, Pa., plant.

The company at present is engaged in the production of seamless tubes up to 15 inches in diameter at Ambridge and produces black and galvanized buttweld and lapweld pipe at the Etna, Pa., plant.

Construction of the new mill at Ambridge is expected to be started in the near future.

Distributing Steam Costs in the Plant

(Continued from page 1128)

3,256 lb. per ton of steel. This rate was higher than normal in the average practice of this mill most of whose product finished larger in section and was carried at higher temperatures. But such are the conditions encountered in making these tests. A series of such tests on various sections would give data that would only be valuable when the engine valves and auxiliaries were maintained uniformly and other conditions remained constant.

However, steam distributed as shown in this series and checked by almost purely mathematical means, give a cost spread that produces no apparent discrimination and is comparable with the results obtained on similar mills elsewhere.
THE BETHLEHEM STEEL COMPANY SPEEDS PRODUCTION
AT ITS SEPARATED PLANTS WITH THE AID OF
TELETYPEWRITER SERVICE

Throughout the industry, The Bethlehem Steel Company is noted for its fast service to customers. This is due in large measure to the rapid and flexible communication between separated plants, made possible by Teletypewriters*. From Bethlehem, Teletypewriter circuits extend to New York, Philadelphia, Buffalo, Johnstown, Coatesville, Lebanon and Steelton, Pa., and Sparrows Point (Baltimore), Md. Private telephone lines connect these and still other properties, move traffic and keep the vast network of blast furnaces, mills and shipyards in constant contact with each other.

As orders are received, they are flashed by Teletypewriter for allocation. Complete details accompany each order. Production—and in some cases shipment—can be started immediately.


Teletypewriters speed business and cut costs for small companies as well as large. They bring separated units "under one roof," whether 300 feet or 3000 miles apart. Your local Bell Telephone Company will gladly give you full information.

*Teletypewriters are connected by Bell System wires in such a way that a message typed on one is reproduced in identical typewritten form at the same moment on any or all connected machines.
Charles E. Skinner, assistant director of engineering, Westinghouse Electric and Mfg. Company, East Pittsburgh, Pa., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1931, as announced at the annual meeting of the Institute held at Asheville, N. C., June 22, during the annual summer convention.

R. D. Bean, formerly manager of the engineering development department of The Brown Instrument Company, Philadelphia, has been made chief engineer of that company. Mr. Bean's extensive field investigation covering many applications of Brown industrial measuring instruments have won him wide acquaintance.

C. B. Pollock, for several years vice president in charge of operations of Newton Steel Company, Newton Falls, O., and Monroe, Mich., is now general superintendent of the Toronto, Ohio, plant of Follansbee Brothers Company, Pittsburgh.

C. G. Bacon, director of wheel research, Armco Railroad Sales Company, Middletown, Ohio, has resigned but is being retained by the company in a consulting capacity in connection with wrought steel wheels.

R. L. Leffler, formerly assistant superintendent of roll shops, Duquesne works, Carnegie Steel Company, Pittsburgh, has been appointed superintendent of blooming mills, roll shops and chipping. Other recent appointments at that plant follow: J.

S. Tannehill, assistant superintendent in charge of rolling; D. A. Crowley, assistant superintendent in charge of chipping; K. H. McLaren, master mechanic.

C. N. Johns has been appointed general manager of the Page Steel and Wire Company, with headquarters at Monessen, Pennsylvania.

William J. Kibler was recently elected president of Buffalo Steel Company, Tonawanda, N. Y., to succeed the late J. G. Joseph. Mr. Kibler has been vice president of the company and in that capacity has been succeeded by August E. Klinger. Both officials have been with the company for more than 20 years.

Edward A. Small, Jr., formerly sales engineer, Jones & Laughlin Steel Corporation, Pittsburgh, has been appointed field engineer for A. M. Byers Company, Conway Building, Pittsburgh. He is a member of the Western Society of Engineers.

J. S. Ferguson, formerly manager of the Columbus, Ohio, plant of American Rolling Mill Company, Middletown, Ohio, has become blast furnace consultant on the staff of Freyn Engineering Company, Chicago, consulting engineer for Soviet Russia. He will be located at Kuznetsk, Siberia, having sailed July 17. Mr. Ferguson has been connected with the Rolling Mill company since 1921. He was transferred to Columbus from its Ashland, Ky., plant. He has supervised blast furnace operation since 1914.
Kinney & Ehlers, Inc., Consulting Engineers, Cincinnati, report that:

"The very satisfactory results we obtained with Bigelow Unit-Suspended Air-Cooled Walls at the plant of Emery Corporation ... constituted a strong influence in our selection of Bigelow Walls for the new plant of The Globe-Wernicke Company."

A. M. Kinney's report also adds that "From our experience, the important details of construction of the Bigelow Wall are (1) each block is individually supported from a bracket, (2) uniformity of refractory thickness, (3) freedom from any large cement-filled expansion joints, (4) ease of repairing small sections and (5) air tightness."

The article "A Low-Cost High-Efficiency Industrial Boiler Plant" that recently appeared in Power describes the installation at Emery Corporation. We shall be glad to send you a reprint of this article, also complete data regarding the Bigelow Unit-Suspended Air-Cooled Wall.

BIGELOW-LIPTAK CORPORATION
5061 WOODWARD AVENUE
DETROIT MICHIGAN

Ralph M. Hoffman, for eight years manager of the Seattle office of the Pacific Division of Link-Belt Company, has been appointed vice president and sales manager of that division, with headquarters at San Francisco. He succeeds Harold H. Clark, who retired on June 1.

E. K. Smith, formerly with the Stockham Pipe and Fittings Company, Birmingham, Alabama, has been appointed metallurgist for the Electro Metallurgical Sales Corporation. Mr. Smith will be located in the Carbide and Carbon Building, North Michigan Avenue, Chicago, and will render metallurgical service to the customers of the Electro Metallurgical Sales Corporation in the Chicago territory.

A. F. Nelson, superintendent of the roll department, Steelton plant, Bethlehem Steel Corporation, has resigned.

Nelson grew up with the old Pennsylvania Steel Company, and was roll designer when this concern was purchased by Bethlehem. As superintendent of the roll department, he has designed and developed all sections rolled at Steelton, one of his last jobs being the design of equipment for the two new heavy rail sections for the Pennsylvania Railroad Company, which were rolled May 1 of this year.

He was also designer for Steelton's rail and structural mill, one of the most flexible mills in the country, on which are rolled the standard tee rails, high tees and girder and guard rails.

Nelson's experience in the line of roll designing has covered almost half a century, and he has originated advanced practice in the rolling of certain shapes and sections.

Chester B. Gleason has resigned from the executive department of the Republic Steel Corporation. In the immediate future he will take a vacation, resuming his activities in the steel industry early in the fall. For years, Mr. Gleason was sales statistician for the Sharon Steel Hoop Company, Sharon, Pa.

H. P. Anderson, identified with Standard Stoker Company, Erie, Pa., has been appointed chief engineer in charge of all engineering inspecting, testing and development activities of the company. He will have offices in Erie and New York.

Archibald Hazlehurst has been appointed manager of sales of the Sterling Steel Foundry Company, Braddock, Pa. He formerly was associated with American Steel Foundries in Chicago and Pittsburgh.

J. C. Williams, president of the Weirton Steel Company, Weirton, W. Va., subsidiary of the National Steel Corp., Pittsburgh, has been made president of the Hanna Furnace Company, Cleveland, also a National subsidiary.

Mr. Williams continues in his capacity as president of Weirton. In his new position he succeeds the late C. A. Collins. Don M. Eddy, who has temporarily occupied the position of president of the Hanna Furnace Company since the death of Mr. Collins resumes his former office as vice president.
ABILITY plus RELIABILITY

THE successful designing and building of such representative machines as these are the result of intelligently organized ingenuity founded upon the extensive knowledge gained in more than a century of specialized engineering experience—hence the reliable performance of our engineers in meeting their problems squarely—and the reliable performance of Wood-built machinery in many lines of industry.
Cause of the Breakage of Sheet Mill Rolls

By F. Johnstone Taylor

(Continued from July issue)

The third zone loses heat at a slower rate by reason of its distance from the surface of the mold and the reduced length of the boundary of the zone, across which its heat is transferred. Solidification is slower and the first and second zones are unaffected by it for a considerable time.

It is the fourth zone which remains liquid over a long period. The shrinkage of the others continues to draw metal away from it, its diminishing periphery slows down the rate of heat loss from the metal, while at the same time the larger periphery of the outer zones allows considerable temperature drop there. The effect, therefore, is that the increasing rigidity of the outer zones prevents the inner zones from affecting the stress conditions to any appreciable extent in those zones and the stress conditions in the inner zones are mainly determined by those in the outer ones. When the third zone solidifies, its shrinkage, while slow, is ultimately retarded by the strong outer zones, with the result that tensile stresses are probably set up in the three principal directions and increased in magnitude up to the center because the visous condition of the last metal to solidify will not allow of the remaining fluid metal following up the shrinkage.

Hair Cracks

The foregoing observations lead up to the probable main cause of the trouble—hair cracks. The stress conditions set up while the roll is cooling are differently affected according to the temperature of the roll when it is removed from the mold and also according to its dimensions. If a large and a small roll be cast at the same time, the small one will be at a much lower temperature than the large one. The temperature gradient in the outer zones of the large roll is consequently much the sharper, the stress conditions would be the more severe and hair cracks are liable to be formed in the chill during the time of the most severe stress. Cracks sometimes occur through the chill of a roll; they may be invisible to the naked eye or they may be wide enough to be easily detected. Some are shallow and are removed when the roll is turned, otherwise it may be deemed necessary to scrap the roll. At the same time cracked rolls have been known to give quite good service which suggests that the cracks were formed in the very earliest stages of cooling in the mold. It is probable that the very thin skin which had rapidly formed was cracked, and afterwards solidification proceeded without the development of further cracking. The cracks while visible would be relatively shallow and it is the fine invisible cracks which are usually the more serious.

Should a crack occur during the later stages of the cooling period there would be no visible evidence of its presence by reason of the unyielding character of the chilled iron and the existence of such a crack promotes its extension, if the stress conditions in the roll are altered as, for example, by rolling. Hair cracks therefore do not necessarily originate at the foundry. They may be produced in the mills if wide temperature variations occur or due to some abnormal loading of the roll due to careless drafting or the pinching of a tongs. But when a hair crack does occur, that will be the position of the ultimate roll fracture, though fracture would not occur immediately it was loaded. The area of the crack gradually extends until the remaining section of the roll is unable to carry the loads.

The usual form of these cracks—often termed "air cracks"—or the roll spoken of as having "taken air"—is crescent shaped and the usual depth is about 4 in. General concensus of opinion inclines to the view that a crack had been present in the chill and that air has thus had ingress to the interior of the roll. These marks are a definite measure of the extent of the cracks in rolls; coloration of the area is only local to the metal adjacent to the crack. A crack in a roll will allow infinitesimal relative movement of the sides of the crack when rolling is in progress as a result of the very small elastic deflections which are produced in the roll as indicated by Fig. 3.
The essential features of this Lewis Plate Shear are motor operated—cut herringbone gears throughout—drive pinion heat treated chrome nickel steel—automatic hold-down—single shot grease lubrication system—cast steel housings—platform for inspection of all gears.

OUR ENGINEERING DEPARTMENT WILL BE GLAD TO SUBMIT PROPOSALS FOR SHEARS OF ALL TYPES AND SIZES.
The steel plant brick mason

Refractories Institute Elects

W. B. Coullie

W. B. Coullie, general sales manager, Harbison-Walker Refractories Company, Pittsburgh, was elected president of the American Refractories Institute at the annual meeting held in St. Louis, recently. Other officers elected were: First vice president, W. J. Westphalen, vice president, Lacelle-Christy Clay Products Company, St. Louis; second vice president, A. P. Taylor, president, Chas. Taylor Sons Company, Cincinnati; treasurer, C. C. Edmunds, treasurer, McLain Fire Brick Company, Pittsburgh; secretary, Dorothy A. Texter.


Fire Brick Plant Purchased by Illinois Steel Company

Holdings of the Kentucky Fire Brick Company, at Haldeman, Ky., have been taken over by Illinois Steel Corporation, with offices in Chicago, Ill.

A. P. Green Opens Alabama Office

The southern headquarters for A. P. Green Co., has been located at Birmingham, Ala., and 16 states will be covered from this office. The branch will be known as the Royal Fire Brick Company, and is located at 1701 First Avenue, South. J. S. Royal is serving as manager of the company.

Development of Mullite Refractories

Dr. T. S. Curtis, vice president in charge of research for The Vitrefrax Corporation, gave a paper on "The Evolution of Mullite Refractories," at the April meeting of the San Francisco Section of the A. S. M. E. The prize for junior members was awarded to E. C. Steffani of the University of Santa Clara for his paper entitled "Development of Insulating and Refractory Brick."

Diederick with Quigley Company, Inc.

A. L. Diederick, Jr., has been appointed advertising manager of the Quigley Company, Inc., New York, manufacturers of high temperature cements, a metal cleaner, "Ana-nite," and other industrial specialties. Mr. Diederick, who was with the American Cyanamid Company, New York, assumed his new duties July 1. He was at one time advertising manager of the A. P. Green Fire Brick Company, Mexico, Missouri.

Concerning Bauxite

Although the greater part of bauxite is used in the production of aluminum, it likewise directly enters into the production of numerous other products, such as refractory materials, abrasives, and chemicals, many of which are of prime importance in industry, states the department of commerce. Research and study are constantly working toward the disclosure of new uses and the reduction of cost of the products derived from bauxite.

France Large Producer

Among the great producing countries of this mineral, France occupies an outstanding place, not only on account of the quality and quantity of the raw material available but also the favorable location of its deposits with respect to transportation. Among the other more important producers are the United States, Surinam, British Guiana, Jugoslavia, Italy, and Hungary. Bauxite is likewise found in less important quantities in Great Britain (county of Antrim, Northern Ireland), Africa, Germany, India, New South Wales, Rumania, Spain, and Russia.
Prior to 1920, the use of Chrome Brick in basic open-hearth furnaces was confined almost exclusively to one or two courses between the silica and magnesite brick in the front and back walls and a few other parts where it was considered necessary to have a neutral refractory between acid and basic refractories.

Lavino Chrome Brick during the past ten years have revolutionized the construction of basic open-hearth furnaces. Today, leading steel companies are building their furnace bottoms, front and back walls with Lavino Chrome Brick.

Many Lavino Chrome Brick bottoms have been in service over nine years and are still giving excellent performance.

Now we offer you a brick of still greater quality, namely, the “IMPROVED” Lavino Chrome Brick.

“IMPROVED” Chrome Brick crack and spall much less than magnesite brick or any Chrome Brick previously made.

Expansion is about half the expansion of magnesite brick. This means that tighter joints can be used without causing distortion and buckling.

Resistance to the molten silica wash from walls and roof is far greater than any magnesite brick. This reduces repairs at the base of front and back walls. “IMPROVED” Lavino Chrome Brick do not hydrate or slake, while all magnesite brick disintegrate very rapidly in the presence of moisture and will slake to a fine dust. It is very rare that a magnesite brick hearth is taken out of a basic furnace and used over again in brick form, because they are usually broken down to a fine powder.

This disintegration of magnesite brick is particularly serious along the front walls where there is usually some leakage from water-cooled doors or door frames.

Chrome Brick resist the action of basic slags and fluxes, equally as well as magnesite brick.

The hot load strength of “IMPROVED” Lavino Chrome Brick is greater than magnesite brick. Ordinary Chrome Brick have much lower hot load strength than magnesite.

The saving in first cost is between $65.00 and $70.00 per thousand, in favor of Chrome Brick. A better product for less money.

Consult one of our refractories engineers on all new applications of IMPROVED Lavino Chrome Brick. Our men are trained to recommend only applications which can be supported by laboratory or performance records.

E.J. LAVINO AND COMPANY

REFRACTORIES DIVISION

CHROME, MAGNESITE AND SILICA REFRactories

BULLITT BUILDING PHILADELPHIA

"Pioneers in Chrome Refractories"
The French bauxite deposits, it is estimated, amount to 60,000,000 metric tons, or sufficient to last 100 years producing at the rate of 600,000 tons per annum. At present and for a number of years past, the principal producer of bauxite has been France, with the main deposits in the department of Var. The bauxite deposits are mined by a few large companies, one of which (Société Anonyme des Bauxites de France) produces approximately 25 per cent of the total output. About half the production of France is consumed in the country and the remainder is exported.

A Study of Refractory Materials*

By Colin Presswood
B. A., F. G. S.

Part III

Spalling is thus due to—
1—The intrinsic expansion of the material, which may be variable even when the temperature rises uniformly.
2—The amount of "glass" present in the brick, and the extent to which it is "elastic" or able to withstand stress outwardly imposed, and the extent to which it is, itself, sensitive to temperature changes.
3—Uneven temperature in the brick.
4—The extent to which the brick is free to expand.

It is probable that by far the greatest damage by spalling is done at relatively low temperatures, say, below 1,100 deg. C. Above this temperature the "glass" begins to soften in part at any rate, and the highly viscous material produced allows the expanding particles to adjust themselves. In silica bricks this is fully realized, as it is well known that cristobalite, the main constituent, expands rapidly at 270 deg. C, but with other bricks which may have regular expansion the point is often overlooked. The expansion characteristics of the principal refractory materials will be illustrated later and will be shown to vary widely as to total amount and the rate at which it takes place.

The manufacturer may modify the spalling tendencies of any materials by careful grading and blending, and control of firing temperature and time (see remarks under Porosity and Density above). In addition, as expansion and contraction movement may be due to the continuance of chemical and physical changes when materials are in use (these changes being incomplete, as mentioned under "After-Expansion"), he can often reduce spalling by completing the changes as far as possible. Thus, fireclay bricks spall less in some cases if a high proportion of the clay be thoroughly shrunk before being finally ground and molded—a point to be elaborated under "Chamotte" bricks in a later article. As a further instance silica bricks may spall less if they are so blended and heated as to convert all the quartz, preferably into tridymite.

The user may overcome spalling troubles by—
1—Slow heating, especially at temperatures where expansion is irregular.*
2—By the provision of "expansion joints" equal to the total reversible expansion of the wall. These may be at intervals—say, 1 in every 100 in. of wall, or around each brick in the form of a tar joint. Magnesite and silica bricks are often set in tar or pitch with advantage.
3—By ensuring that, as far as possible, all parts of the furnace wall are heated simultaneously, and such devices as tie-rods adjusted properly.

The investigation of spalling in the laboratory is by no means a success as yet, and there is no accurate index figure of "spallability." The matter has been widely considered—e.g., by A. T. Green, in England, and by Norton, in U.S.A.—and attempts at evolving a formula from which tendency to spall might be estimated are interesting.

Thus, Norton calculates spalling tendency as—

\[ S \text{ varies as } \frac{D}{h^2} \]

where \( D = \) Coefficient of expansion, \( h = \) "Diffusivity," \( p = \) Maximum shear strain, and finds the values roughly proportional to laboratory tests of spalling.

"Diffusivity," the significance of which has been emphasized by A. T. Green, is calculated as—

\[ h = \frac{k}{c \cdot g} \]

where \( k = \) conductivity, \( g = \) density, \( c = \) specific heat.

It is clear that the rate of heat diffusion through a mass depends on each of these three factors, and that upon "diffusion" of heat throughout the thickness of a wall depends the temperature gradient which imposes a stress if there be expansion.

In the laboratory spalling tendency may be roughly measured by the number of heatings and coolings a brick will undergo before 20 per cent of its weight is lost by spalling. In the most commonly accepted form this test comprises closing the "doorway" of a furnace (maintained constantly at 1,350 deg. C.) with five or six bricks in such a way that only the ends of the bricks are exposed to the heat. No jointing is used, and the bricks are not fitted tightly into the doorway. They are exposed for one hour to the temperature, and then the hot

*Metallurgia.

*See curves in article published January, 1930.
Because of several recent developments in the technique by which Corhart Electrocast Refractories are electrically melted and poured, this company can now offer recuperator tiles and special shapes for many unusual refractory needs.

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2. High Fusion Point. Electrocast has a fusion point of cone 35, without any appreciable softening range below that point. Under standard load tests the deflection is zero.

3. Resists Corrosion. Because of its unique combination of low porosity and high fusion point, and its insolubility in molten fluxes, Corhart Electrocast is unusually resistant to the corrosive action of slags and glasses.

4. Harder than Glass. Therefore ideal for use in any application in which ordinary refractories usually crack and abrade.

5. Withstands Temperature Changes. Because of its thorough annealing, Electrocast withstands rapid temperature changes much more readily than a body of its density would indicate.

Corhart Electrocast is now being used by almost every large glass company in America, by many outstanding metallurgical industries and by several leading cement manufacturers.

If you are having refractory troubles of any sort, we suggest that you get the facts about Corhart Electrocast. We may be able to help. If not, we shall frankly say so. Write now for Bulletin 51-B, and for the full details about tiles and other special shapes. No obligation—no high-pressure follow-up. Address: Corhart Refractories Co., Incorporated, 16th and Lee Streets, Louisville, Kentucky.
ends are immersed in running cold water for a fixed time. The time of subsequent steaming is also fixed and the operation repeated.

This serves to distinguish between broad classes of bricks—e.g., silica and sillimanite—but it is doubtful if the differences shown between bricks of the same class correspond to differences in furnace observations. For bricks with high spalling tendency the test has to be much less drastic if slight improvements are to be detected—e.g., an air blast may be used for cooling.

The "simulative furnace test" to which reference is made elsewhere, is being used in this connection, and here the whole test furnace wall, built of the same or various bricks, is alternately heated and cooled. No test or calculation serves, however, to indicate positively the spalling tendency in any large-scale furnace results.

**Slag Resistance**

There is no standard test of slag resistance, the difficulty being to reproduce faithfully all the factors contributing to destruction by slag. It seems likely that the "simulative furnace test" being developed in America will prove most satisfactory. In this, a small furnace is lined with bricks to be tested and fired by the method used in large-scale practice, if possible. The furnace may be rotated in order to reproduce "scouring action" of slag, and the slag may be introduced cold and melted with or without metal, or, as in tests of boiler furnace refractories, it may be introduced as a fine powder under pressure either through the burner or separate orifice.

The method is costly and lengthy, but seems capable of yielding valuable and accurate results. Simpler, quicker, and cheaper tests are—

(a) Melting the slag on the face of the test brick.
(b) Melting in pockets molded or drilled into the brick.
(c) Melting in crucibles made of the brick mixture.

In all these there are obvious objections, and furnace conditions are not reproduced. They give a broad indication, however, and, are, therefore, useful, though a test will have to be standardized if it is to be really valuable to users in deciding on the suitability or otherwise of a brick.

Slag attack, or resistance, is both a physical and a chemical problem. The general principles governing selection of refractories are well known. A basic brick—e.g., magnesite—for a "basic" slag; an acid brick, as silica, for "acid" slag; a chrome brick for ferruginous slags; sillimanite for highly alkaline dust and ashes, as yielded, for instance, by high-temperature wood fires.

Physically, slag attack can be viewed mechanically. Thus, if the constituent particles of a brick are only loosely held together, they are detached easily by moving viscous slag. If the brick is porous then thin slags, dust, and corrosive gases can easily penetrate. These, however, are only general conclusions, for, as mentioned earlier, in one case, at least, very porous, coarse, weak, friable, fireclay bricks (made on the high-grog principle) are proving excellent as boiler furnace linings. The results are difficult to explain, but it may be that the corrosive dust, etc., which first enters the face of the brickwork dissolves the surface of the particles, and is thereby increased in viscosity and refractoriness. The surface of the bricks would thus become cemented by a highly viscous, moderately refractory slag.

Slag attack may, to some extent, be reduced by the furnace user if he bears in mind the general principles underlying it, and adopts a fairly obvious precaution and one feasible in many cases—viz., to coat his brickwork with a thin layer of special cement or with a glaze which can either be produced by a mild flux or by a period of over-heating.

**A Review of Certain Gas Producer Practice**

(Continued from page 1123)

the Illinois Steel Company in 1912-14 and in 1922. While practice in different works varies through a wide range, owing to local circumstances and material available, yet their paper, representative of practice at that plant, forms a milestone in the industry and serves as a marker of progress. The following figures, partly from this paper and partly from other sources, show an improvement in practice as time goes on. Not allocating credit quantitatively as between furnaces and producers, yet the indications are that producer improvements have affected the situation largely and favorably, as shown in Table VI.

Instead of closing this paper with a prophecy of future capacity and performance of gas producers, a record of recent performances is given. This may serve as an incentive to still more noteworthy operation in the future.

<table>
<thead>
<tr>
<th>Coal</th>
<th>Pennsylvania, bituminous, 44.5% fine, 13,515 B.t.u. per pound as used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasification Rate</td>
<td>62,620 lbs. in 8.25 hrs. = 7,590 lbs. per hr. This was at the end of a run of 60% hours in a pipe mill of a 10 ft. diameter producer.</td>
</tr>
<tr>
<td>Gas Constituents</td>
<td>CO 24 %; CO2, 54%.</td>
</tr>
<tr>
<td>Gas Gross Calorific Value</td>
<td>167 + B.t.u.</td>
</tr>
<tr>
<td>Gas Temperature</td>
<td>1,400 °F.</td>
</tr>
<tr>
<td>Gas Pressure</td>
<td>0.8 in. water.</td>
</tr>
<tr>
<td>Steam Pressure for Turbo-Blower</td>
<td>75 lbs. per sq. in.</td>
</tr>
<tr>
<td>Air Pressure Blower Outlet</td>
<td>4.5 in. water.</td>
</tr>
</tbody>
</table>
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- Michigan Steel Castings Co.
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- Mesta Machine Co.
- Michiana Products Corp.
- Standard Alloy Co., Inc.
- Union Steel Cast Co.

#### Annealing Furnaces and Ovens.
- Combustion Engineering Corp.
- General Electric Co.
- Mc Cann-Harrison Corp.
- Morgan Construction Co.
- Rockwell Co., W. S.

#### Annealing Pots.
- Blaw-Knox Co.
- Casey Co., The Philip
- Michiana Products Corp.
- Standard Alloy Co., Inc.
- Union Steel Cast Co.

#### Arches—Suspended.
- Interlocking Arch Co.

#### Asbestos Lumber.
- Casey Co., The Philip
- Johns Manville Corp.

#### Ash Conveyors.
- Combustion Engineering Corp.
- Link-Belt Co.
- Robins Conveying Belt Co.

#### Automatic Control—Gas Pressure and Flow.
- Bailey Meter Co.
- Shaffer Ross Control Systems Co.

#### Baffles—Monolithic.
- General Refractories Co.
- Harbison-Walker Refractories Co.
- Johns Manville Corp.
- Quigley Co., Inc.

#### Balls—Cast Iron Chilled.
- Fuller Lehigh Co.

#### Bearings and Hangers—Shaking.
- Lint Belt Co.
- Timken Roller Bearing Co.

#### Beaters.
- Hiltner, Joseph L.

#### Bell Hoist.
- Frew Engineering Co.

#### Belt Conveyors.
- Lint Belt Co.
- Robins Conveying Belt Co.

#### Benches—Draw Wire, Rivet and Wood.
- Morgan Construction Co.

#### Benzol Recovery Plants.
- Bartlett Hayward & Co., The
- Koppers Construction Co., The
- Western Gas Construction Co., The

#### Bessemer Tuyeres.
- Climax Fire Brick Co.

#### Blast Furnaces.
- Freyn Engineering Co.
- McKee & Co., Arthur G.
- Mohr & Sons, John

#### Blast Furnace Specialties.
- Bartlett Hayward & Co., The
- Llinois Refractories Co., John
- Western Gas Construction Co., The

#### Blowers—Turbine.
- General Electric Co.

#### Blowing Engines.
- Mesta Machine Co.

#### Blow Torches—Acetylene.
- Linde Air Products Co., The

#### Boiler Wall Coating.
- Carborundum Co., The
- Corhart Refractories Co., Inc.
- Illinois Clay Products Co., John
- Johns Manville Corp.
- Quigley Co., Inc.
- Refractory & Engineering Co.

#### Boilers—Electric.
- General Electric Co.

#### Boilers—Waste Heat.
- Bartlett Hayward & Co., The
- Combustion Engineering Corp.
- Frew Engineering Co.
- Mohr & Sons, John
- Western Gas Construction Co., The

#### Boilers—Water Tube.
- Combustion Engineering Corp.

#### Brake Band Lining.
- Johns Manville Corp.

#### Brake Blocks.
- Johns Manville Corp.

#### Brakes—Electric, Magnetic, Crane.
- Cutler-Hammer Inc.
- General Electric Co.

#### Brick—Blast Furnace.
- Climax Fire Brick Co.
- General Refractories Co.
- Harbison-Walker Refractories Co.
- Llinois Clay Products Co., John

#### Brick—Boiler Settings.
- Climax Fire Brick Co.
- Frew Engineering Co.
- Harbison-Walker Refractories Co.
- Corhart Refractories Co., Inc.
- Harbison-Walker Refractories Co., John

#### Brick—By-Product Coke Ovens and Gas Plants.
- Corhart Refractories Co., John
- Harbison-Walker Refractories Co., John
- Illinois Clay Products Co., John

#### Brick—Calcine.
- General Refractories Co.
- Harbison-Walker Refractories Co., John

#### Brick—Chrome.
- General Refractories Co.
- Harbison-Walker Refractories Co., John

#### Brick—Electrolytically Fused Alumina Plants.
- Carborundum Co., The

#### Brick—Heat Insulating.
- Armstrong Cork & Insulation Co.
- Carborundum Co., The
- Illinois Clay Products Co., John

#### Brick—Magnesite.
- General Refractories Co.
- Harbison-Walker Refractories Co., John

#### Brick—Silica.
- General Refractories Co.
- Harbison-Walker Refractories Co., John

#### Buckets—Automatic Dump.
- Brosius, Inc., Edgar E.

#### Buckets—Clamshell, Drag Line, Grab, etc.
- Blaw-Knox Co.
- Brosius, Inc., Edgar E.
- Link Belt Co.

#### Buckstays—O. H.
- Blaw-Knox Co.
- National Roll & Fdry. Co.

#### Buildings—Portable Steel.
- Blaw-Knox Co.

#### Bulkheads—O. H.
- Blaw-Knox Co.
- National Roll & Fdry. Co.

#### Burners.
- Combustion Engineering Corp.
- Hagan Co., George J.
- Rockwell Co., W. S.
- Surface Combustion Corp.
- Swindell-Dresser Corp.

#### Burners—Boiler.
- Anthony Co., The
- Surface Combustion Corp.
- Swindell-Dresser Corp.

#### Burners—Powdered Coal.
- Combustion Engineering Corp.
- Fuller Lehigh Co.

#### By-Product Coke and Gas Oven Plants.
- Koppers Construction Co., The
By-Product Recovery Plants.
Bartlett Hayward Co., The
Western Gas Construction Co., The

Calcium Carbide.
Linds Air Products Co., The
Guthmann Engineering Co.

Calcium-Silicon.
Electro Metallurgical Sales Corp.

Calcium-Aluminum-Silicon.
Electro Metallurgical Sales Corp.

Calcium-Manganese-Silicon.
Electro Metallurgical Sales Corp.

Carbon Burning Equipment—Acetylene.
Linds Air Products Co., The

Cars—Air Dump, Narrow Gauge.
Western Wheeled Scraper Co.

Cars—Air Dump, Standard Gauge.
Mager Car Corp.
Western Wheeled Scraper Co.

Cars—Charging and Ingot Mold.
International Clay Machinery Co.
Mackintosh-Hemphill Co.
Mesta Machine Co.
Morgan Foundry Co., The
Union Steel Casting Co.
Weilman Eng. Co.

Cars—Coal, Side and End Dump.
Western Wheeled Scraper Co.

Cars—Dump.
Atlas Car & Mfg. Co., The
Youngstown Fdry. & Mach. Co.

Cars—Flat.
Western Wheeled Scraper Co.

Cars—Hand Dump, Narrow Gauge.
Western Wheeled Scraper Co.

Cars—Hot Steel.
Blaw-Knox Co.
Youngstown Fdry. & Mach. Co.

Cars—Industrial.
Atlas Car & Mfg. Co., The
Youngstown Fdry. & Mach. Co.

Cars—Scale and Ladle Transfer.
Atlas Car & Mfg. Co., The
McKee & Co. & Arthur G.
Youngstown Foundry & Mach. Co.

Cars—Spreader, Narrow and Standard.
Western Wheeled Scraper Co.

Carts—Dump.
Western Wheeled Scraper Co.

Cartridge Fuses—Renewable and Non-Renewable.
D & W Fuses Works of General Electric Co.

Castings—Alloy.
Machiana Products Corp.
Standard Alloy Co., Inc.
Treadwell Engineering Co.
Union Steel Casting Co.

Castings.
Birdsboro Steel Fdry. & Mach. Co.
Borg, Switch & Mfg. Co., The
Fuller Lehigh Co.
Hagan Co., George J.
Lewis Foundry & Machine Co.
Link Belt Co.
Mackintosh-Hemphill Co.
Mesta Machine Co.
Michigan Steel Castings Co.
Morrison Co., J. S.
National Roll & Fdy. Co.
Poole Engineering & Machine Co.
Standard Alloy Co., Inc.
Union Steel Casting Co.

Castings—Brass.
Mackintosh-Hemphill Co.
Morgan Engineering Co., The

Castings—Chilled Iron.
Fuller Lehigh Co.

Castings—Electric Steel.
Link Belt Co.
Michigan Steel Castings Co.
Standard Alloy Co., Inc.
Treadwell Engineering Co.

Castings—Gear.
Birdsboro Steel Fdry. & Mach. Co.
Lewis Foundry & Machine Co.
Link Belt Co.
Mackintosh-Hemphill Co.
Mesta Machine Co.
Michigan Steel Castings Co.
Treadwell Engineering Co.
Union Steel Casting Co.
United Engineering & Fdy. Co.

Castings—Gray Iron.
Fuller Lehigh Co.
Lewis Foundry & Machine Co.
Link Belt Co.
Mackintosh-Hemphill Co.
Treadwell Engineering Co.
Union Steel Casting Co.
Western Gas Construction Co., The

Castings—Gray Iron and Steel.
Link Belt Co.
Mackintosh-Hemphill Co.
Mesta Machine Co.
National Roll & Fdy. Co.
Treadwell Engineering Co.

Castings—Malleable Iron.
Link Belt Co.

Cement.
Coenart Refractories Co., Inc.
General Refractories Co.
Harbison-Walker Ref. Co.
Haws Refractories Co.
Lavino & Co., E. J.

Central Station Equipment.
Bailey Meter Co.
Fuller Lehigh Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Chain—High Temperature Alloy.
Machiana Products Corp.
Michigan Steel Castings Co.
Standard Alloy Co., Inc.

Chain Grates.
Combustion Engineering Corp.
Hagan Co., George J.

Charging Boxes.
Blaw-Knox Co.
Mesta Machine Co.
Morgan Engineering Co., The
Union Steel Casting Co.

Charging Machines—Furnace.
Blaw-Knox Co.
Mesta Machine Co.
Morgan Engineering Co., The
Union Steel Casting Co.

Chromes Ore.
General Refractories Co.
Harbison-Walker Ref. Co.
Lavino & Co., E. J.

Clay—Fire.
General Refractories Co.
Harbison-Walker Ref. Co.
Illinois Clay Products Co.

Clutches.
Cutler-Hammer, Inc.
Johns-Manville Corp.
Link Belt Co.

Clutches—Friction.
Link Belt Co.

Coal—Plants for Powdering.
Blaw-Knox Co.

Coal Tips and Trestles.
Blaw-Knox Co.
Link Belt Co.

Cone worm—By-Product—Cross Regenerators.
Koppers Construction Co., The

Commutators.
General Electric Co.

Compressors—Gas.
Mesta Machine Co.

Concrete—Steel Forms for Construction.
Blaw-Knox Co.

Condensers.
Blaw-Knox Co.

Condensers—Barometric, Surface.
Mesta Machine Co.

Construction—Blast Furnace.
Blaw-Knox Co.
H. A. Bramert Co.
Frye Engineering Co.
Laughlin & Sons Co., Alex.
McKee & Co., Arthur G.
Mehr & Sons, John.
Shaw-Welsh Co., The.

Construction—Gas Works.
Bartlett Hayward Co., The
Blaw-Knox Co.
Western Gas Construction Co., The

Construction—Plate.
Bartlett Hayward Co., The
Blaw-Knox Co.
Western Gas Construction Co., The

Construction—Structural Iron Steel.
Bartlett Hayward Co., The
Blaw-Knox Co.
Western Gas Construction Co., The

Continuous Rolling Mills.
Mackintosh-Hemphill Co.
Mesta Machine Co.
Morgan Construction Co.
Morgan Engineering Co., The
Treadwell Engineering Co.

Control—Automatic Combustion.
Blaw-Knox Co.
Shallcross Control Systems Co.

Controllers—Automatic for Cranes.
Cutler-Hammer, Inc.
General Electric Co.

Control—Drainage.
Bailey Meter Co.

Controllers—Enclosed Drum Type for Cranes.
Cutler-Hammer Inc.
General Electric Co.

Controllers—Electric, for Steel Mill Machinery.
Cutler-Hammer, Inc.
General Electric Co.

Controllers—Magnetic.
Cutler-Hammer, Inc.

Controllers—Manual, Automatic, Machine Tool, Crane, Coal and Ore Bridges.
Cutler-Hammer, Inc.
General Electric Co.
Morgan Engineering Co., The
Westinghouse Electric & Mfg. Co.

Controller Valves.
Bailey Meter Co.
Bristol Co., The
Shallcross Control Systems Co.
Conveyors — Billet.
Link-Belt Co.
Morgan Construction Co.

Conveyors — Coke, Ore, Flux.
Robins Conveying Belt Co.

Conveying System — Fuller-Kinyon
for Pulverized Coal.
Fuller-Lehigh Co.

Cooling Beds.
Aetna-Standard Eng. Co., The
Lewis Foundry & Machine Co.
Mackintosh-Hemphill Co.
Morgan Construction Co.
Morgan Engineering Co., The
The Treadwell Engineering Co.

Cooling Plates.
Blaw-Knox Co.

Cooling Tables.
Birdsboro Steel Fdry. & Mach. Co.
Blaw-Knox Co.
Morgan Construction Co.
Morgan Engineering Co., The
National Roll & Fdry. Co.
Treadwell Engineering Co.

Couplings — Flexible.
Bartlett-Hayward Co., The
De Lamar Steam Turbine Co.
General Electric Co.
Link-Belt Co.
Mesta Machine Co.
Moore Steam Turbine Corp.
Morse Chain Co.
Poole Engineering & Machine Co.

Couplings — Friction Clutch.
Bartlett-Hayward Co., The
Link-Belt Co.

Couplings — Shaft.
Link-Belt Co.

Couplings — Rigid.
Link-Belt Co.

Couplings — Universal.
Lewis Foundry & Machine Co.
Mackintosh-Hemphill Co.
Mesta Machine Co.

Coverings for Cold Pipes.
Carey Co., The Philip
Johns-Manville Corp.

Cranes.
Link-Belt Co.
Morgan Engineering Co., The

Cranes — Electric Traveling.
Morgan Engineering Co., The

Crank Shafts.
Mesta Machine Co.
Union Steel Casting Co.

Crawler Type Cranes.
Link-Belt Co.

Crushers — Coal.
Link-Belt Co.

Crushers — Rock and Ore.
Robins Conveying Belt Co.
Western Wheeled Scraper Co.

Crushers — Roll.
Fuller-Lehigh Co.
Link-Belt Co.
Robins Conveying Belt Co.

Cupola Linings.
Climax Fire Brick Co.
Cohort Refractories Co., Inc.
General Refractories Co.
Harbison-Walker Refractories Co.
Johns-Manville Corp.

Cutouts.

Cut Bar Carrier.
Blaw-Knox Co.
Link-Belt Co.

Cutting Apparatus — Oxy-Acetylene.
Linde Air Products Co., The

Dampening.
Carey Co., The Philip
Johns-Manville Corp.

Decarbonizing Equipment.
Linde Air Products Co., The

Dehydration — Gas.
Western Gas Construction Co., The

Digesters.
Blaw-Knox Co.

Displacement Systems — Tar.
Western Gas Construction Co., The

Draught Fans.
Air Preheater Corp., The

Draft Control.
Shalercoals Control Systems Co.

Driers — Indirect Heat.
Combustion Engineering Corp.
Fuller-Lehigh Co.

Driers — Rotary.
Combustion Engineering Corp.
Fuller-Lehigh Co.

Driers — Chain.
Link-Belt Co.
Morse Chain Co.

Driers — Gear, Rope.
Gears and Forgings Inc.
Link-Belt Co.
Mesta Machine Co.
Poole Engineering & Machine Co.
Robins Conveying Belt Co.

Drys—Mill.
Birdsboro Steel Fdry. & Mach. Co.
Gears and Forgings Inc.
Lewis Foundry & Machine Co.
Link-Belt Co.
Mesta Machine Co.
Morgan Construction Co.
Morgan Engineering Co., The
National Roll & Fdry. Co.
Poole Engineering & Machine Co.

Dynamos.
General Electric Co.

Economizers.
Combustion Engineering Corp.

Electric Furnaces.
Blaw-Knox Co.
General Electric Co.
Pittsburgh Electric Furnace Corp.
Rockwell Co., W. S.
Westinghouse Electric & Mfg. Co.

Efficiency Instruments.
Bailey Meter Co.
Bristol Co., The
General Electric Co.
Leeds & Northrup Co.

Electric Insulation.
Johns-Manville Corp.

Electric Light Equipment.
General Electric Co.

Electric Locomotives.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Motors.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Ovens.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electric Steam Boilers.
General Electric Co.

Electric Welding Apparatus.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Electro Metallurgical Sales Corp.

Engineers — Consulting.
Brassett & Co., H. A.
Bray Engineering Co.
Laughlin & Co., Alex.
Lofthus, Peter F.
McKee & Co., Arthur G.
Morgan Construction Co.
Murray Inc., Thomas E.
Perin Engineering Co., Inc.
Rockwell Co., W. S.
Shover, Barton K.
Wortington, Warren

Engineers and Contractors.
Bartlett Hayward Co., The
H. A. Brassett & Co.
Bray Engineering Co.
Laughlin & Co., Alex.
McKee & Co., Arthur G.
Morgan Construction Co.
Morgan Engineering Co., The
Rockwell Co., W. S.
Rust Engineering Co., The
Swindell-Dressler Corp.
Treadwell Engineering Co.
Wean Engineering Co.

Engine Stops.
Swindell-Dressler Corp.

Engines.
Mackintosh-Hemphill Co.
Mesta Machine Co.
United Engineering & Fdry. Co.

Engines — Blowing (Gas and Steam Driven).
Mesta Machine Co.

Engines — Corliss.
Mesta Machine Co.

Engines — Gas.
Mesta Machine Co.
United Engineering & Fdry. Co.

Engineers — Hoisting.
Mesta Machine Co.
Treadwell Engineering Co.

Engines — Steam, Unbowl.
Mesta Machine Co.

Equipment — Welded Chain, Wire and Wire Nail Mills — Complete.
Morgan Construction Co.

Evaporators — Multiple.
Bartlett Hayward Co., The
Treadwell Engineering Co.

Exhaustors — Gas.
De Lamar Steam Turbine Co.
Moore Steam Turbine Corp.

Extractors — Tar.
Bartlett Hayward Co., The
Blaw-Knox Co.
The Western Gas Construction Co., The

Fast’s Flexible Couplings.
Bartlett Hayward Co., The

Feeder — Pulverized Coal.
Combustion Engineering Corp.
Fuller-Lehigh Co.

Feeder — Ore, Coal, Coke, Flux.
Robins Conveying Belt Co.

Ferro Alloys.
Electro Metalurgical Sales Corp.
Lavin & Co., E. J.

Flash furnace equipment.
Morgan Construction Co.

For Pulverized Coal.

Frame Furnaces.
Bartlett-Hayward Co., The

Drawbenches, Tubes and Bars.
Aetna-Standard Engineering Co.

Driers — Direct Heat.
Combustion Engineering Corp.
Fuller-Lehigh Co.

Elevators and Conveyors.
Link-Belt Co.
Robins Conveying Belt Co.

Engineers — Consulting.
Brassett & Co., H. A.
Bray Engineering Co.
Laughlin & Co., Alex.
Lofthus, Peter F.
McKee & Co., Arthur G.
Morgan Construction Co.
Murray Inc., Thomas E.
Perin Engineering Co., Inc.
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Morgan Engineering Co., The
Rockwell Co., W. S.
Rust Engineering Co., The
Swindell-Dressler Corp.
Treadwell Engineering Co.
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United Engineering & Fdry. Co.

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Mesta Machine Co.

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Mesta Machine Co.

Engines — Gas.
Mesta Machine Co.
United Engineering & Fdry. Co.

Engineers — Hoisting.
Mesta Machine Co.
Treadwell Engineering Co.

Engines — Steam, Unbowl.
Mesta Machine Co.

Equipment — Welded Chain, Wire and Wire Nail Mills — Complete.
Morgan Construction Co.

Evaporators — Multiple.
Bartlett Hayward Co., The
Treadwell Engineering Co.

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Moore Steam Turbine Corp.

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Blaw-Knox Co.
The Western Gas Construction Co., The

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Bartlett Hayward Co., The

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Fuller-Lehigh Co.

Feeder — Ore, Coal, Coke, Flux.
Robins Conveying Belt Co.

Ferro Alloys.
Electro Metalurgical Sales Corp.
Lavin & Co., E. J.

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For Pulverized Coal.

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Bartlett-Hayward Co., The

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Aetna-Standard Engineering Co.

Driers — Direct Heat.
Combustion Engineering Corp.
Fuller-Lehigh Co.

Elevators and Conveyors.
Link-Belt Co.
Robins Conveying Belt Co.
Ferro-Cromium. Electro Metallurgical Sales Corp.
Ferro-Manganese. Electro Metallurgical Sales Corp.
Ferro-Silicon. Electro Metallurgical Sales Corp.
Ferro-Zirconium. Electro Metallurgical Sales Corp.

Fuel Oil—Strainers.
Friction Blocks.
Frames—Open Hearth. Morgan Construction Co.


Furnace Insulation. Carey Co., The Philip Johns-Manville Corp.

Gas—Automobile and Tractor Lighting. Linde Air Products Co., The


Gas Holders. Bartlett Hayward Co. The Western Gas Construction Co., The

Gas Oven Plants. Koppers Construction Co., The


Furnaces—Sheet and Tin Mill. McMann-Harrison Corp. Weyn Engineering Co.

Furnaces—Soaking Pits. Rust Engineering Co., The


Gas—Plant Machinery. Bartlett Hayward Co., The Link Belt Co. Western Gas Construction Co., The

Gas Plant—Coal. Bartlett Hayward Co., The

Gas Plants—Water, Blue. Bartlett Hayward Co., The Western Gas Construction Co., The

Gas Plants—Water Carbureted. Bartlett Hayward Co., The Western Gas Construction Co., The


Gas Purification—Dry Process. Western Gas Construction Co., The

Gas Purification—Liquid Process. Western Gas Construction Co., The

Gas Scrubbers. Bartlett Hayward Co., The H. A. Brassert & Co. Western Gas Construction Co., The


Gas—Welding and Cutting. Linde Air Products Co., The

Gases—Argon, Helium, Neon. Linde Air Products Co., The

Gaskets. Johns-Manville Corp.

Gasoline Absorption Plants. Bartlett Hayward Co., The Koppers Construction Co., The

Gages—Acetylene, Oxygen. Linde Air Products Co., The

Gages—Pressure, Draft, Volume. Bailey Meter Co. Bristol Co., The

Gears—Welding.
Linde Air Products Co., The

Goggles—Welding.
Linde Air Products Co., The

High Temperature Cement.
Carborundum Co., The
Carry Co., The Philip
General Refractories Co.
Harrison-Walker Refractories Co.
Johns-Manville Corp.
Lavois & Co., E. J.
Quigley Co. Inc.
Refractory & Engineering Corp.

Hoists—Electric.
General Electric Co.

Hose—Rubber, Oxy-Acetylene.
Linde Air Products Co., The

Hose Connections—Oxy-Acetylene.
Linde Air Products Co., The

Housing Screws.
Simonds Manufacturing Co., The

Housing Screw Boxes.
Simonds Manufacturing Co., The

Treadwell Engineering Co., Union Steel Casting Co.

Hydraulic Machinery.
Birdsboro Steel Fordy. & Mach. Co.
Mesta Machine Co.

Hydraulic Valves.
Birdsboro Steel Fordy. & Mach. Co.
Wood & Co., R. B.

Hydraulic Packing.
Johns-Manville Corp.

INDICATORS—Valve Position.
Western Gas Construction Co., The

Indicators—Gas Holder Position.
Western Gas Construction Co., The

Instruments—Efficiency.
Bailey Meter Co.
Bristol Co., The
General Electric Co.
Leeds & Northrup Co.

Instruments—Indicating and Recording.
Bailey Meter Co.
Bristol Co., The
General Electric Co.
Leeds & Northrup Co.

Insulating Materials—Varnish, Sheet-
ing, Tape Compound.

Cary Co., The Philip
Johns-Manville Corp.
Westinghouse Electric & Mfg. Co.

Insulation—Pipe and Boiler.
Armstrong Cork & Insulation Co.
Cary Co., The Philip
Johns-Manville Corp.

Joints—Expansion.
Western Gas Construction Co., The

Jointless—Compression.
Blaw-Knox Co.

Kilns—Cement.
Blaw-Knox Co.
Moir & Sons, John

Kilns—Dry Gas.

Kilns—Lime.

Kilns—Pulverizers.

Ladles.
Blaw-Knox Co.
Moir & Sons, John

Lathes—Roll.
Birdsboro Steel Fordy. & Mach. Co.
Lews Foundry & Machine Co.
Mackintosh-Hempill Co.
Mesta Machine Co.
National Roll & Foundry Co.
Pittsburgh Rolls Corp.
United Engineering & Fdry. Co.

Lead Burning Equipment—Acety-
lene.
Linde Air Products Co., The

Leucorecmct Rapid Steel Furnaces.
Pittsburgh Electric Furnace Corp.

Linings—Ladle.
General Refractories Co.
Illinois Clay Products Co.

Linings—Tub and Ball Roller or Rod Mill.
Faller Lehigh Co.

Link-Belt Silent Clam.
Link Belt Co.

Liquid Level.
Bailey Meter Co.
Bristol Co., The
Leeds & Northrup Co.

Locomotive Cranes.
Link Belt Co.

Locomotives—Electric.
General Electric Co.

Locomotive Manufacturers.
Heisler Locomotive Works
Porter Co., H. K.

Locomotive—Steam.
Heisler Locomotive Works

Locomotive—Industrial.
Heisler Locomotive Works
Porter Co., H. K.

Locomotives—Storage Battery.
General Electric Co.

Lubricants.
Keystone Lubricating Co.

Lubricants—Gear, Wire Rope, etc.
Keystone Lubricating Co.

Machinery—Rolling Mill.
Aetna-Standard Eng. Co., The
Bailey Meter Co., The
Birdsboro Steel Fordy. & Mach. Co.
Lews Foundry & Machine Co.
Mackintosh-Hempill Co.
Mesta Machine Co.
Morgan Construction Co.
Morgan Engineering Co., The National Roll & Foundry Co.
Pittsburgh Rolls Corp.
Screeter & Hartley, Inc.
Thomas Spacing Machine Co.
Treadwell Engineering Co.

Machinery—Tin Plate.
Aetna-Standard Eng. Co., The

Machinery—Special.
Birdsboro Steel Fordy. & Mach. Co.
Gears and Forgings Inc.
International Clay Machinery Co.
Lews Foundry & Machine Co.
Mackintosh-Hempill Co.
Mesta Machine Co.
Morgan Engineering Co., The National Roll & Foundry Co.
Simon Manufacturing Co., The
Screeter & Hartley, Inc.
Sutton Engineering Co.
Thomas Spacing Machine Co.

Machinery—Tin Plate.
Aetna-Standard Eng. Co., The

Metal Glasses—Welding.
Linde Air Products Co., The

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

Mfg., Mach. & Ac.

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This Steel Mill saved the cost of operating two large hydraulic pumps, simply by stopping the losses of high pressure water through valves controlling furnace doors and dampers in their Open Hearth Department.

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The results were even beyond the expectations of these men, because they showed that so much leakage had been eliminated by the drop-tight Homestead Operating Valves that they could cut out two pumps and still maintain the normal operating pressure of the plant. In addition they benefited by the greater ease of operation, lower maintenance costs, and more positive control afforded by Protected Seat Hydraulic Operating Valves.

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The Protecting Sleeve is your sole protection against undue water losses, and is your assurance against costly delays. No other valve has this feature. Be sure to specify Protected Seat Operating Valves for your next hydraulic operating valve requirements.

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**Finishing Unit**
Continuous Pack Heating Furnace, Self Discharging, Mechanical Feeder and Catcher.

Licensed under Patents and Patents Pending. The Combination of Continuous Furnaces and Mechanical Equipment for 2 High Mills and license to operate in this manner can be furnished only by The Wean Engineering Co., Inc.

The Wean Engineering Company, Inc.
Warren, Ohio

Flinn & Dreffein Co.
Associated Companies

The McKay Machine Co.
LEEDS & NORTHRUP COMPANY PRESENTS

MICROMAX
THE IMPROVED L & N POTENTIOMETER PYROMETER

MICROMETER SENSITIVITY,
SELF-STANDARDIZATION
AND HIGH-SPEED RECORDING

NOW comes the fully automatic potentiometer—
Micromax—the improved L & N Potentiometer
Pyrometer, embodying basic improvements,
raising the potentiometer pyrometer to a new high
level of accuracy, of reliability and of strictly auto­
matic operation.

Like the announcement made over twenty years
ago, when Leeds & Northrup introduced the first
industrial potentiometer pyrometer, today’s an­
nouncement brings pyrometer users basic new advan­
tages—a new order of sensitivity, speed, accuracy and
reliability.

No Daily Attention—No Adjustments

The new Micromax “scissor-action” balancing device is so
microscopically sensitive that it will detect deflections of the
galvanometer pointer amounting to 1/1000th of an inch. It is
practically unaffected by wear. It requires no adjustments. Its
recording action is responsive and speedy as no potentiometer
recorder has ever been—so fast that the pen or print-wheel on a
Micromax Recorder will step across the entire 9½ inches of
calibrated chart in less than twenty-two seconds. Its non-slip
clutch is automatically prevented from attempting to move the
mechanism beyond either end of the scale.

Micromax is the fully automatic industrial potentiometer
pyrometer. It needs no daily attention; the instrument circuit
in every model is standardized automatically, every forty-five
minutes or less, more accurately than can be done manually.

To industry in general, and in particular to the many thousands
of present users of L & N Potentiometer Pyrometers, Micromax
is presented as the culmination of over twenty years of speciali­
zation in industrial potentiometer pyrometers and of three years
of concentrated work in the final development of its particular
refinements.

Branch Offices:
Pittsburgh  Cleveland
Detroit  Chicago  St. Louis
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LEEDS & NORTHRUP
4901 STENTON AVENUE
PHILADELPHIA, PA.

SEND FOR YOUR COPY
OF NEW CATALOG
V-87

A NEW STANDARD OF ACCURACY AND DEPENDABILITY IN INDUSTRIAL PYROMETERS
Why Silico-Manganese Alloys
Deoxidize Open Hearth Steel Faster
and Better

When silicon and manganese are added to steel in basic or acid furnaces as a combination alloy, they deoxidize the bath faster and better than when added individually. The manganese silicate formed by their reaction with iron oxide is enormous in size as compared with the original iron oxide, and it rises with greater rapidity.

Silicon and manganese may be introduced either as Silico-Spiegel or as Silico-Manganese.

Electromet Silico-Spiegel is an electric furnace product made under the supervision of experts. It contains 7 to 8 per cent. silicon, 25 to 30 per cent. manganese, and less than 4 per cent. carbon.

To open hearth operators who prefer a more concentrated alloy, Electromet also offers Silico-Manganese containing 12 to 14 per cent. silicon, 65 to 70 per cent. manganese, and less than 5 per cent. carbon. Since this alloy produces a quicker reaction than Silico-Spiegel, the temperature of the metal is not lowered to the same extent. Also, smaller amounts can be used.

The speed and economy that Electromet Silico-Manganese alloys introduce into open hearth practice make them the ideal deoxidizing materials in your plant.

Electromet Metallurgical Engineers will be glad to furnish any further information you require.

Electro Metallurgical Sales Corporation
Unit of Union Carbide and Carbon Corporation

Electromet Ferro-Alloys & Metals
The Big 4 of M-H CO. ROLLS

1-AMPLE-STRENGTH
INSURES TONNAGE-PRODUCING DRAFTS.

2-LONG-WEAR
MEANS MORE FIRST GRADE TONNAGE PER DRESSING, AND PRODUCT EXACT TO GAUGE AND WEIGHT.

3-NON-SLIPPAGE
FACILITATES AT CAPACITY PERFORMANCE THE ENTRANCE AND DELIVERY OF THE PIECE.

4-ANTI-FIRECRACKING
ELIMINATES THE "LIFE-SHORTENING" HEAVY DRESSINGS, AND TROUBLESOME — OFTEN IRREMEDIBLE — SURFACE DEFECTS OF THE PRODUCT.

MACKINTOSH-HEMPHILL CO.
ESTABLISHED 1803 AT PITTSBURGH

General Offices:
Point Building, Penn Avenue at Water Street
PITTSBURGH, PA.

Garrison Division
PITTSBURGH, PA.

Midland Division
MIDLAND, PA.

Wooster Division
WOOSTER, OHIO
NAME your hoisting objective and Wellman engineers will design and build equipment that will accomplish it successfully and economically.

Wellman engineering has produced machinery that has won a name throughout the world.

***

WELLMAN PRODUCTS INCLUDE:

- Steel and Tube Mill Equipment
- Gas Producers, Flues, etc.
- Gas Reversing Valves
- Car Dumper, all types
- Coal and Ore Handling Equipment
- Coke Oven Machinery
- Charging Machines and Manipulators
- Safety Stops for Traveling Bridges
- Special Cranes
- Mining Machinery
- Castings and Machine Work to customers’ drawings

The Wellman Engineering Co.

Engineers

Constructors

Manufacturers

Cleveland, Ohio

New York at 30 Church St., Birmingham at 1101 Webb Crawford Bldg.
Chicago at Room 523-549 West Washington Blvd.

Mexico City at Edificio Oliver, 16 De Septiembre No. 5.
Milla Pinions

To withstand the extremely heavy and intermittent tooth loads encountered, accurately cut teeth are essential for long life in Rolling Mill Pinions. The result is smooth and quiet running, producing a finer finished product.

Mesta Cut Tooth Mill Pinions have accurate teeth with bearing across the entire face and are free from excessive backlash with both extremely large and fine pitch.

Double Helical — Single Helical — Straight Spur
Carbon Steel or Alloy Steel
Forged or Cast Steel
Planed tooth or Hobbed tooth Any Size

Mesta Machine Company
Pittsburgh, Pa.
MORGAN • PLATE • MILL

MORGAN 46" 2-HIGH UNIVERSAL PLATE MILL

Especially designed and built for the A. M. Byers Company’s Ambridge, Pa. plant for rolling wrought iron plate.

THIS mill is successfully rolling universal wrought iron plate and 84" sheared plate with vertical rolls removed. All Tables, Transfer, Hot Bed and Shears were designed and built by Morgan.

Table rollers, drive shafts, etc., are provided with roller bearings, thus reducing maintenance to the minimum.

Write for Bulletin No. 16

THE MORGAN ENGINEERING COMPANY
NEW YORK 25 BROADWAY
ALLIANCE, OHIO, U.S.A.

MORGAN DESIGNS AND BUILDS
Blooming Mills • Plate Mills
Structural Mills • Continuous Mills
Rod and Bar Mills
Electric Traveling Cranes
Steam Hydraulic Forging Presses
Steam Hammers
The illustration of a sprocket and endless chain shows but two out of many thousands of types of castings produced by us to render a definite service under predetermined conditions.

Each of these products represents values in the collective form of experience and knowledge gained by our organization specializing for more than fifteen years in the design, application, and manufacture of special alloys for resisting heat and corrosive influences.

All castings may have the same general outward appearance, but there are three factors to consider in every metallurgical problem where performance under heat is required.

First—Mechanical or stress resistance values in relation to work done. Second—Structural characteristics making for performance of operation. Third—Outside dimensions and forms.

MICHIANA PRODUCTS CORPORATION
MI\CHIGAN CITY • INDIANA
Isley
Furnace Control

Replaces: Reversing Valves and Stacks
Increases: Production, Furnace Life, and Regeneration
Reduces: Fuel Consumption, Repairs, and Costs

Unparalleled for
Open Hearth, Soaking Pit, Forge,
Reheating and all other Regenerative

Furnaces

Using
Fuel Oil, Tar, Natural Gas,
Coke Oven Gas, Producer Gas, Blast Furnace Gas, and Mixed Gas.

Morgan
Construction Co.

WORCESTER, MASS., U. S. A.
INSTALLATIONS of FREYN-DESIGN STOCKLINE RECORDERS proves superiority of electrical method for preheating sheet and tin mill rolls

That satisfactory performance is attained is indicated by the fact that over 40 per cent of these installations were purchased on repeat orders.

Freyn-Design Stockline Recorders are made in single, dual, triple and quadruple types for handling 1, 2, 3 or 4 test rods. There are 9 installations of the Freyn-Design Dual Stockline Recorder.

Let us send you an illustrated booklet describing the Freyn-Design Stockline Recorder.

Freyn Engineering Company
CONSTRUCTORS — ENGINEERS — SPECIALTIES
310 SOUTH MICHIGAN AVENUE — CHICAGO U.S.A.
WHY USE... ELECTRIC ROLL HEATERS?

Because—

1. Electric Roll Heaters eliminate warming-up iron which commands no ready market.
2. Electric Roll Heaters increase first turn tonnage from 4000 to 5000 lbs.
3. Electric Roll Heaters reduce scrap loss to normal turn rates.
4. Use of Electric Roll Heaters reduces roll breakage.
5. Electric Roll Heaters make possible mid-week preheating of rolls.

WRITE FOR BOOKLET
A booklet descriptive of Freyn-Design Electric Roll Heaters will be sent at your request.

There are 325 installations of Electric Roll Heaters. Practically all of the large manufacturers of high grade sheets use them. That satisfactory results are secured is apparent from the large number of repeat orders for this equipment.

Freyn Engineering Company
CONSTRUCTORS ENGINEERS SPECIALTIES
310 SOUTH MICHIGAN AVENUE • CHICAGO U.S.A.

ASSOCIATED WITH:
ASHMORE, PENSON, PEASE & CO. LTD., STOCKTON-ON-TEES, ENGLAND.
SECOMET, 64 RUE LA BOETIE, PARIS, FRANCE.
McCANN SHEET DISCHARGER

Automatically opens furnace door and delivers sheet or pack from inside furnace to mill or mill feeding table.

Sheets Delivered at Furnace Temperature . . . . . In combination with McCANN WALKING BEAM FURNACE and modern automatic handling equipment through the mill, maximum production of high grade sheets at an extremely low cost is assured.

All auxiliary equipment for full or semi automatic operation is available.

McCann-Harrison Corporation
Cleveland, Ohio
Linde Process Service is within economical 'phoning distance

Every user of Linde Oxygen is privileged to call upon Linde Process Service for assistance or advice through any of the 25 Linde District Offices.

Linde Process Service, with its unequalled background of scientific research and field experience, offers every facility for most effective use of oxy-acetylene welding and cutting. Here are some of the things it has done.

In the State of Washington, it developed a Procedure Control for welding band saws, thus saving the lumber industry thousands of dollars in replacement costs.

In Iowa, it showed a hosiery mill how to alter forms used in the manufacture of silk stockings, and helped save a capital expenditure of $16,000.

In Minnesota, it showed a steel company how to effect substantial savings in the reclamation of copper tuyeres.

In New York, it showed a manufacturer how to apply iridium to fountain pen points economically and without waste.

These examples illustrate why users of Linde Oxygen gain so much extra value from their use of the oxy-acetylene process. If you are interested in knowing what Linde Process Service can do for you, write or telephone the nearest Linde District Office.

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation

159 Producing Plants UCC
IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE
This Carey Alumino Hi-Temp is twice as efficient as ordinary heat insulation

(ABOVE)
A Carey Alumino Hi-Temp insulating wall made up of (A) one row of 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x\(\frac{3}{4}\) in. fire brick; (B and C) two rows of 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x36 in. Carey Alumino Hi-Temp; and (C) one row of 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x9 in. red brick.

(LEFT)
The ordinary insulating wall consisting of (D) 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x9 in. fire brick; (E and F) two rows of 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x9 in. insulating brick; and (G) one row of 2\(\frac{3}{4}\)x2\(\frac{3}{4}\)x9 in. red brick.

The Scientific Successor to Insulating Brick

CAREY Alumino Hi-Temp is the alumina base heat insulation recently developed after years of laboratory research. Practical tests have demonstrated its superiority for insulating high temperature furnaces, lehrs, kilns, regenerator chambers, drying and calcining tunnels, and similar structures with internal temperatures ranging from 1000 degrees to 2500 degrees Fahrenheit.

Alumino Hi-Temp has been proven to be twice as efficient in insulating value as the best of six ordinary insulating bricks. Only about half the thickness is therefore required, thus saving space. Alumino Hi-Temp Blocks are 36" x 9" in size, and this large unit reduces installation labor and minimizes the heat losses through joints.

We will supply, on request, copies of the tests referred to above, and also complete data concerning the use of Carey Alumino Hi-Temp in any proposed installation.

THE PHILIP CAREY COMPANY :: Lockland, Cincinnati, Ohio
Branches in Principal Cities

BUILT-UP ROOFS
ASPHALT PRODUCTS
ELASTITE EXPANSION JOINT
WATERPROOFINGS
ROOF PAINTS

HEAT INSULATIONS
ASBESTOS MATERIALS
CAREYSTONE CORRUGATED SIDING
ASFALTSLATE SHINGLES
BUILDING PAPERS
ONE feature of this recuperator that appeals to industry is the ease with which it can be added to present furnace equipment.

For instance, it is not necessary to reconstruct your furnaces.

The vertical type recuperator in most cases does not require a stack.

Reversing valves and regenerators are eliminated—and simultaneously firing at both ends of the furnace is made possible.

This recuperator has made possible the successful use of scrubbed blast furnace gas supplied at atmospheric temperature.

The resulting operation compares most favorably with the best regenerative practice and first cost is materially reduced.

The Carborundum Company Recuperator has no moving or metal parts subject to deterioration under severe temperature conditions.

Tubes of “Carbofrax,” the Carborundum Brand Silicon Carbide Refractory are employed for transmitting heat from waste gasses to air for combustion.

These tubes show astonishingly long life—have remarkably high heat conductivity and refractoriness.

[ Our Engineering Staff will gladly give you more details ]

THE CARBORUNDUM COMPANY, Perth Amboy, N.J.
"NATIONAL"
ROLL
ROLLING MILL MACHINERY
Weight — Rigidity — Workmanship

Why Experiment? Use the Best

We Specialize in
Sheet, Tin and Plate Rolls, Special Chilled Rolls, Cold Rolls, Sand Rolls, Extra Hard Rolls for Brass, Copper, Aluminum

The National Roll & Foundry Company
Office and Works: AVONMORE, PA., U.S.A.
PORTER measures locomotive service in definite figures ...

A large eastern machine tool manufacturer saves $2760.00 per year or a net annual return of 67% on the investment with a Porter Fireless Locomotive. A large Central Station Power Plant switches standard gauge coal cars at a daily cost of only $8.78 with a Porter ... a large Montana Tie Treating Plant hauls lumber at a total cost of only $0.006 per gross-ton-mile ... a great steel plant moves 40 to 50 cars of coke over extensive trackage at a daily cost of only $2.63 for steam ... another large eastern Central Station has saved $4680.00 over a period of 8 years ... these are only a few random figures taken from certified Nielsen Survey Reports that measure the great dollars and cents economy and performance of the wonderful Porter Fireless Locomotive.

Why not investigate its possibilities in your plant?

H. K. PORTER COMPANY
PITTSBURGH, PA.
NEW YORK OFFICE 44 Whitehall Street
Established 1865 CHICAGO, OFFICE Wells St. and Wacker Drive
BUILDERS OF STEAM, FIRELESS STEAM, GASOLINE-ELECTRIC
OIL-ELECTRIC, GASOLINE AND COMPRESSED AIR LOCOMOTIVES
NEW simplicity, compactness and high efficiency in driving industrial equipment at less-than-motor speeds are afforded by new Westinghouse-Nuttall drives consisting of induction motors and speed reducers combined into single units.

With power and speed reduction confined to one piece of equipment, drives can be installed in much less space with fewer mounting and aligning operations. This means lower installation costs. High operating efficiency and decreased upkeep expense are assured by the reduced number of driving parts required. These economies can be realized in powering either single or multi-speed operations.

Gearmotors for single speed applications are built in standard sizes of \( \frac{1}{2} \) to 15 hp. with output speeds ranging from 1550 down to 69 rpm. Multi-speed drives, consisting of \( \frac{1}{2} \) to 15 hp. motors combined with adjustable speed reduction units, provide four different operating speeds which can be instantly changed under load with the motor running.

Ask the nearest Westinghouse sales office for details about these new drives that created so much interest among the engineers at the recent Iron and Steel Exposition in Cleveland.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse
PUMPS designed for high pressures and high temperatures

The unit here shown delivers 500 gal. per min. against 1500 lbs. per sq. in., at 3500 r.p.m.

DE LAVAL CENTRIFUGAL PUMPS for feeding high pressure boilers are distinguished by:

1—Solid (not split) diaphragms between stages,
2—Heavily bolted casings,
3—Casings supported near the center line of the shaft,
4—Special water cooled stuffing boxes, and
5—Perfect hydraulic balance.

DeLaval Steam Turbine Co., Trenton, N.J.
Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Double Helical Speed Reducing Gears, Worm Reduction Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery
Your motor should breathe clean air

When dust and soot collect in air passages and windings of motors, circulation is reduced. The result is local overheating and short circuits—serious menaces to operating efficiency and costs.

Forced ventilation with clean, filtered air as provided by American Air Filters—Multi-Panel type—insures the life and performance of these motors.

American Air Filters are designed for steel mill requirements. They are built for steel mill service. They have proved themselves in the last three years to be steel mill air filters.

Let us tell you how American Air Filters can solve your operating problems, and your problems of general ventilation. No obligation. Address: American Air Filter Co., Incorporated, 109 Central Avenue, Louisville, Kentucky.
Mantle Recuperators

Assure 20% to 30% fuel saving on average

Preheating of incoming combustion air by metallic recuperation is the surest, proven way to reduce fuel consumption on the average industrial furnace. Mantle Recuperators on furnaces throughout the country are saving 20% to 30% ... quickly paying for installation costs.

The Type SF Mantle Recuperator shown in the photograph below is installed on a tube reheating furnace in a large steel mill. Fuel consumption is 25,000 cubic feet coke oven gas per hour. Flue gas temperature at furnace downtake is 2150 deg. F. Air temperature 850° F.

Fuel saving 30 per cent!

You will be interested in having the new MANTLE RECUPERATOR CATALOG and data book. It contains valuable information on modern metallic recuperation and its application to industrial furnaces of different types.

Operated by Henry L. Doherty & Company

Surface Combustion

Surface Combustion Corporation
Toledo, Ohio

Sales and Engineering Service
In Principal Cities
The trunnions had to be right, so Pollock used "Univan" that tough steel.

When this Pollock ladle swings into action to pour 125 tons of molten metal, the entire weight of metal and ladle turns on trunnions of "Univan", that tough steel, which more than met the rigid specifications demanded by Pollock. Why not have the security and safety that "Univan" gives? Where castings must meet severe strains and stresses, resist fatigue and shocks, specify "Univan" and avoid breakdowns.

Union Steel Casting Co.
Pittsburgh, Pa.
MORE than 35 years of experience in operating, designing and building steel plants are available to you if you are planning the rehabilitation of your existing equipment or the installation of extensions. Designs are based on thorough and practical analyses of your requirements from an operating standpoint, detailed plans and layouts are submitted, and undivided responsibility is taken for the completed project.

Brassert service also includes investigations and surveys of the entire range of operations in the iron, steel and allied industries, together with analyses and recommendations on management and operation, appraisals and financial and technical reports.

H.A. BRASSERT & CO.
ENGINEERS AND CONTRACTORS
CHICAGO
LONDON
310 S. Michigan Avenue
Brookhouse-Walbrook E. C. 4
The True Yardstick of Advertising Value of Any Publication is Its Editorial Content.

The high quality of the editorial content of BLAST FURNACE AND STEEL PLANT determines its reader interest and reader interest determines its outstanding circulation.

That is why BLAST FURNACE AND STEEL PLANT is the type of technical publication which keen industrial advertisers use in this day of specialized markets. Its editorial policy is directed to a definite group of individuals in a definite industry, i.e., the managing and operating men of the steel producing industry.

Each editorial article and news item is of vital interest to this particular group. Over 72% of the subscriptions are sent by request, to the subscriber's home. This is reader interest fixed and certain.

Blast Furnace & Steel Plant Has a Greater Circulation in the Steel Plants Than Any Other Two Steel Publications Combined.

That the most influential men of the steel industry turn to BLAST FURNACE & STEEL PLANT as the official clearing house of reliable information on the latest advances in steel plant operation and procedure, is reflected in the latest circulation report.

This official report gives BLAST FURNACE & STEEL PLANT a total net paid circulation of 3,389—greater than the combined circulation of any two other steel papers in the field.

76.25% of the circulation of BLAST FURNACE & STEEL PLANT goes to general superintendents, managers, chief and department engineers, chemists and metallurgists, foremen, rolling mill superintendents, roll designers, roll turners, draftsmen and safety inspectors.

15.44% of the circulation goes to companies and executives. This makes a total usable advertising circulation to you of 91.69%—a potent field indeed for your sales message.

Therefore,—if your product is used in the steel industry—if you want the advantages of a concentrated market—if you want maximum coverage—if you want the cream of the buying power in the steel industry—then by all means make BLAST FURNACE AND STEEL PLANT your key publication.
Leading Equipment Manufacturers in every industrial field desiring to incorporate simplicity, durability, and precision performance into the drive of their products have enhanced the sales value of their product by standardizing on IXL Speed Reducers.

Embodyed in IXL Reducers is the best that engineering skill, precision manufacturing methods, and carefully selected materials can produce. Their design is based on a careful study of the requirements in various industrial fields, backed by a thorough knowledge of speed reducer design and manufacture gained over a period of thirty years.

IXL Speed Reducers are made in Spur, Worm, Helical, and Herringbone Types for horizontal, vertical, or right angle drives—fractional H.P. up to 300 H.P. and reduction ratios from 2 to 1 up to 50000 to 1. There's a size and type for every possible requirement.

Let our Engineers figure on your requirements. Helpful and instructive data sheets for requesting recommendations sent on request.

**IXL HYGRADE Worm Gear Speed Reducers**

Send for the latest Foote Bros. Data Book on IXL HYGRADE Worm Reducers chock full of invaluable information on worm gear evolution, design, and applications with data, tables, formulae curves, problems, etc.

**Use the Coupon**

B.F.&S.P.-306

Foote Bros., Gear and Machine Co.
215 N. Curtis St.
Chicago, Ill.

The IXL HYGRADE Worm Gear Speed Reducer Handbook will be sent without cost to any executive or engineer in U. S. A., Canada or Mexico.

Name__________________________

Address________________________
REPLACEABLE WEARING STRIP

TWIST GUIDES

Replaceable Wearing Strip (Roof Pat'd Type) guides are covered by U.S. patent 1,655,845 and are manufactured solely by the Michigan Steel Casting Company.

IMPORTANT savings of inventory and time result from the use of Replaceable Wearing Strip Twist Guides. Compare the cumbersome old style guides with the light, easy to handle wearing strips which average only 10% of the total weight of entire guide. They are the only part that need replacing. MISCO wearing strips of different angles for various passes and degree of twist fit the same cast electric alloy steel holders. It is therefore sound economy to change wearing strips only instead of entire guides.

Complete information is contained in illustrated bulletin No. 2

MICHIGAN STEEL CASTING COMPANY
1988 GUOIN STREET  •  DETROIT, MICHIGAN
In Inland's Blast Furnaces and Coke Ovens
As In Inland's Open Hearths
Refractories Like These Serve in Blast Furnaces, Hot Blast Stoves, Coke Ovens and Open Hearths of the INLAND STEEL COMPANY

During 1929, Inland Steel Company increased the average life of their open hearth furnace roofs 21.2%—by the use of Harbison-Walker silica refractories. Despite the fact that during 1929, Inland rebuilt two more furnaces than in 1928—installed a new 100 ton furnace and produced more steel than in the previous year. Inland, by the use of Harbison-Walker refractories reduced their silica requirement by 120,000 brick (9 inch equivalent).

In view of performance, it is not surprising to find that Harbison-Walker brick line their four blast furnaces; Harbison-Walker brick line fourteen Hot Blast stoves; Harbison-Walker silica brick are used in their 214 Koppers By-Product ovens, and Harbison-Walker silica brick in their 27 open hearths.

Throughout the steel industry you'll find a preference for Harbison-Walker refractories—a preference earned by performance records similar to those established in the open hearths, blast furnaces and coke ovens of the Inland Steel Company.

HARBISON-WALKER REFRACTORIES COMPANY
World's Largest Producer of Refractories
PITTSBURGH, PENNSYLVANIA
OFFICES IN PRINCIPAL CITIES
Close control in OWENS-ILLINOIS LEHRS means ARMSTRONG INSULATION

Bottles as small as thimbles, as large as pails . . . bottles for drugs, bottles for pickles . . . round bottles, flat bottles, square bottles . . . these are the world-famous products of the Owens-Illinois Glass Company’s factory at Charleston, West Virginia, one of the largest glass bottle plants in the country.

In this plant, it is said, "the closest control is exercised over the manufacturing processes in order to meet rigid inspection tests." For instance, in the annealing lehrs used here, one form of close control is careful insulation. Seven electric lehrs of the most recent design are insulated with Armstrong’s Insulating Brick.

Many other glass and ceramic plants, in addition to Owens-Illinois, have found Armstrong’s and Nonpareil Insulating Brick ideal insulation for high temperature furnaces. The insulating efficiency of both brick is high—a factor which saves many times their cost in wasted fuel each year.

Armstrong’s and Nonpareil Insulating Brick are machine-sized on all flat surfaces. They are accurate to within .004”. The practical result of this accuracy is found in easier laying up and a tighter, more efficient job.

Armstrong’s Insulating Brick withstand temperatures up to 2500°F, behind the refractory. Nonpareil serve up to 1600° without warping or fusing. Both come in all standard fire brick sizes and shapes, and special sizes to order.

We will gladly give you facts and figures to show how these brick can save you money in high temperature installations. Ask for our free bulletins and a sample of each brick.

Armstrong’s and Nonpareil Insulating Brick

For Furnaces, Ovens, Kilns, and Lehrs
TUBE normalization is an exacting heat treating operation. It demands accurate furnace atmospheric conditions and control—a furnace where time and heat cycles are regulated perfectly and exactly. Surface Combustion designed and built the continuous gas-fired tube normalizing furnace illustrated in this advertisement for a prominent Pennsylvania steel company. Results, after months of operation, have been beyond expectation. Tubes averaging 9¾ in. diameter are normalized at the rate of 20 tons an hour. Surface Combustion has made revolutionary developments in tube normalizing furnace design...demonstrated by successful installations in many leading tube mills of the country.

This Surface Combustion tube normalizing furnace is fired with SC 2-stage high pressure burners...utilizing 1000 B.t.u. natural gas at 20 lbs. pressure.

WE WILL EXHIBIT AT THE NATIONAL METAL EXPOSITION, BOSTON, SEPTEMBER 21-25 SPACE X-6

Surface Combustion operated by Henry L. Doherty & Company
The rotating parts of TYPE MD MOTOR are designed and built to last

CAREFULLY designed rotating parts, built to last under conditions that are always severe, contribute greatly to the stamina of General Electric Type MD—the standardized mill motor.

Consider the commutator with its V-clamping construction for greatest strength, and with its accurately gauged mica and copper segments for minimum maintenance. Note the strong mica end cones and the mica protective cylinder which slips under the commutator. Also notice the heavy ears to which armature conductors are soldered.

Armature coils are insulated with mica and asbestos to withstand high temperatures easily. Notice full support afforded coils at each end. After these coils are assembled, a temporary banding is put on and complete armature is baked, allowing coils to “settle”. This is an example of extra care in manufacture.

Armature bands are soldered with high-melting-point solder. Complete assembly is dipped several times in insulating varnish and baked, assuring a winding that is practically impervious to moisture, and one that will stand high operating temperatures and other abuse.

*The Type MD is designed to meet the standardized dimension and rating specifications of the A. I. & S. E. E.
BROSIOUS
AUTO FLOOR CHARGER

The Brosious Auto Floor Machine is designed for handling slabs, billets, ingots, etc., and for serving hammers, presses, open hearth and electric furnaces, cupolos, etc.

It provides modern, efficient, mechanical handling, is inexpensive and self contained, and eliminates overhead runways and requires no rails on the floor.

It operates in restricted areas, is easily handled, and is faster in operation than any other type of charger, its only requirement being a good floor on which to operate.

Write for full information.

Other BROSIOUS Equipment

Overhead Charging Machines
Auto Floor Manipulators
Single Hoist Charging Machines

Single Hook Buckets
Automatic Dump Buckets
Automatic Single Hoist Buckets

Hydro-Electric
Automatic Clay Guns
Double Barrel
Automatic Steam Guns

Cinder Notch Stoppers
Dry Slag Granulating Mills

Goggle Valves
Coke Testing Tumbling Barrels

EDGAR E. BROSIOUS INC.
ENGINEERS and MANUFACTURERS
PITTSBURGH SHARPSBURG BRANCH PA.
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Published the first of each month by Steel Publications Incorporated
Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.

DON N. WATKINS, President
D. S. WATKINS, Vice President
M. M. ZEDER, Secy.-Treas.

EASTERN MANAGER
ROBERT E. POWELL
29 West Thirty-fourth Street
New York, N. Y.

WESTERN MANAGER
GLEN W. NEELY
165 West Monroe Street
Chicago, Ill.

Subscription Price:—In the United States, $2 per year; Canada, $2.50; all foreign countries, 15 shillings. Single Copy 25 cents.
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Accident
Prevention

On October 12 delegates to the Twentieth Annual Safety Congress will gather in Chicago for the purpose of advancing the cause of accident prevention. To the country at large and the steel industry in particular, the work of these delegates is of great importance, for their accomplishments are measured in an increase or a decrease in accidents and in loss of life. They should have, therefore, the earnest support of everyone, and especially of those at the head of our various industries.

The steel industry should be in the forefront in lending encouragement to the safety first movement; for, owing to the nature of the work, a man occupied in the manufacture of steel is subjected to somewhat greater hazards than in other manufacturing processes. It is true that these hazards are rapidly being eliminated, but the task of educating men and of safeguarding them from machinery must be carried on until the chance of accident is reduced to a minimum. This task our safety directors are endeavoring to perform and at times the work, principally because of the perversity of man, is most discouraging.

That the officials of our steel companies are not unmindful of the good resulting from a well organized safety campaign is apparent, and that their interest will be maintained seems assured. However, in these days when demands of a humanitarian nature are ever present, the cause of Safety First should elicit the full sympathy and support of everyone.
... and it's suggestive to the extent of affecting a savings in steel casting costs about the steel plant or rolling mill.

Check, if your records be convenient, the average operating life of—say—coupling boxes and spindles (selected in view of punishment subjected). If they be of straight carbon composition, note their cause of replacement. You'll invariably find rejection due to rounded pods through constant wear—fractures, resultant of starting loads or reversals of stress—misalignment, breaking down wabbler end of rolls... Common faults as described, and as associated with various steel castings of the mill can, in most cases, be remedied with the substitution of an alloy steel of well balanced content.

Birdsboro-30, copper-molybdenum casting steel, has greatly increased the life of coupling boxes and spindles by imparting higher physicals and added toughness... We've a bulletin that deals with these units exclusively... Won't you write?
Some notes on Western Pennsylvania and West Virginia

Pioneer Blast Furnaces

By M. W. VON BERNEWITZ
Mining and Metallurgical Engineer
Pittsburgh

SEVENTY pages of Swank's "History of the Manufacture of Iron in All Ages" (second edition, 1892) describe in readable style the beginning of iron making in Pennsylvania in 1716 and up to 1891, but his 554-page work lacks illustrations and does not give much concerning the furnaces to be herein described. Occasionally, some publication shows the remains of a pioneer blast furnace, and as the writer and others took photographs of and collected a few items regarding four of them last summer, these are now submitted for the interest of readers. The pictures show the stone
construction of these once useful furnaces, also their fair condition. No equipment remains.

The Fayette Furnace

One hot day last August, R. D. Leitch of Pittsburgh and the writer were along Indian Creek Valley, Fayette County, and among the trees not far from a dirt road we could see the furnace shown in Fig. 1. We examined it inside and outside, and grab sampled what remained of the slag dump. The slag contains 0.68 per cent total iron. John L. Gans, managing editor of The Courier at Connellsville, informed the writer as follows regarding this furnace: It is the Fayette, built under the direction of Major James Rogers in 1827-'28, and was kept in blast by his successors, Joseph and George Rogers, and Dr. Joseph Rogers, until 1841. Since then it has been idle. The furnace, which has an air-cooled wall, was charged with native iron ore mined and charcoal made nearby. The iron was largely used in making kettles, cooking utensils, and other products which were sold at the furnace and transported to Connellsville on wagons and sleds, and shipped by flatboats to Pittsburgh. The Fayette was one of a series of iron working establishments in the Indian Creek Valley, but not the oldest; the St. John furnace, farther down stream, was built in 1807 by Jackson and Gibson, and later became the property of Colonel James Paull.

The Ritter and Buena Vista Furnaces

M. F. Brandon of Vintondale, Cambria County, Pennsylvania, supplied R. D. Leitch with the following notes on the Ritter and Buena Vista furnaces: Figs. 2 and 3 were photographed by the latter.

Fig. 2 (left) shows the front and Fig. 2 (right) shows the rear of the Ritter furnace, formerly known as the Eliza furnace. It was begun in 1846 by Ritter and Rogers and completed in 1847 by Ritter and Irwin. It is situated at Vintondale, five miles west of Ebensburg, on Black Lick Creek.

Fig. 3 shows the Buena Vista furnace, about 11 miles west of Ebensburg, on Black Lick Creek. It was built by McClelland and Company in 1847 and was owned by Dr. Alexander Johnston. The furnace made 560 tons of metal in 1854 from bog iron ore in the neighboring coal measures. It has been idle since 1856.

Both of these furnaces are now owned by a coal...
company which offered the Ritter to Henry Ford. However, residents protested and expect to repair the furnace themselves.

The Laurel Hill Furnace

The Laurel Hill furnace (Fig. 4) in the Ligonier valley, near New Florence, Westmoreland County, Pennsylvania, interested C. H. Herty, Jr., of Pittsburgh, who saw it recently. M. A. Hotham of Monessen, whose grandfather, by contract, furnished the teams and wagons, and hauled the iron and charcoal from the mountains to this and other furnaces, states that the Laurel Hill was built, operated, and went out of business before the Civil War. The iron was hauled from the furnace in wagons to the Conemaugh River and loaded on flat-boats which, when the water was high enough, floated to Pittsburgh. Some of the iron was taken across the river to a place called Centerville, now Huff, and shipped to Pittsburgh by way of the old Pennsylvania canal.

A Furnace of 1930

By way of comparison with these pioneer furnaces, Fig. 5 is submitted as an example of a modern blast furnace making more than 1,000 tons of iron a day—No. 1 of the Weirton Steel Company, Weirton, West Virginia.

This furnace has a hearth diameter of 25½ ft., a bosh diameter of 28½ ft., and is 9½ ft. high from the center line of the iron notch to the top ring. The cubical capacity from the bottom of the closed bell to the iron notch is 40,000 cu. ft. It has a daily production of 1,035 tons of iron, according to information supplied by W. F. Morris, Jr., vice president of the Weirton Steel Company.

The great furnace just described is not quite four miles from a pioneer furnace on Kings Creek, Hancock County, West Virginia, the first (1790 to 1800) built west of the Allegheny mountains. Fig. 6 shows what remains of it. There is enough stonework left to show the original outline and size of the furnace, which was built by Peter Tarr, who arrived in this country from Prussia near the close of the Revolutionary War. The lining shows signs of the heat that smelted the iron ore and limestone from nearby hills. Charcoal made from the local forests was used as fuel, and wind was produced by a stream flowing over a water wheel. This furnace made 2 to 3 tons of pig iron a day, and ox-teams hauled it to market, probably as distant as Pittsburgh. Metallurgically, according to H. McDonnell of the Weirton Steel Company, this old furnace did just as good as the No. 1 furnace is doing today, but whereas the pioneer furnace made 25 tons in a week, the present one makes that quantity every half-hour.

A Typical Coal or Producer Gas Flame for Steel Heating, with Natural or Coke-Oven Gas

By Lee Wilson

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A Typical Coal or Producer Gas Flame for Steel Heating, with Natural or Coke-Oven Gas

By Lee Wilson

RECENTLY a hot mill superintendent showed the writer a coke oven gas fired pack furnace, which had all the appearances of being coal fired. The furnace was filled with a short, mellow, smoky red haze. The superintendent stated that from his standpoint it was a perfect heating condition. There was no sign of rash heating with its resultant finishing scale. The packs were evenly heated and well soaked. The roller was finishing four sheets doubled of 28-gage in three passes, which of course meant a very small percentage of scrap or cutdowns.

Later in the day the furnace was used for heating iron dipped in a 1 per cent charcoal solution, to be for full finish automobile sheets. For heating loose iron, some of the air was cut off the burners, and an even heavier smoky red haze prevailed in the furnace. There seemed to be a very light deposit of smoke or fixed carbon on the top and bottom sheets as they came from the furnace, and the charcoal could still be seen on the inside sheets even after rolling. Loss from finishing scale was practically unknown on this mill.

An analysis of this furnace condition from a combustion standpoint is interesting. The burning equipment consisted of a fan for supplying air, a proportional valve for proportioning air and gas, and two burners of the controlled luminous flame type. The question is immediately asked: What is controlled luminous flame combustion?

As applied to natural or coke oven gas, it is the principle of separating the gases of the hydrocarbon series so as to have free hydrogen and fixed carbon. The hydrogen burns as a gas, and the carbon burns as a solid fuel about the same as finely powdered coal. Carbon burns very slowly in comparison to gaseous fuels, and has more of the appearance of a (Continued on page 1224)
Effect of open-hearth practice on

Blisters in Plate Mill Steel

By DR. I. N. GOFF and T. S. WASHBURN

THIS article is part of a research investigation which has been conducted on the effect of open-hearth practice upon the quality of plate mill steel. Although this investigation has not been completed, the results to date have shown the importance of certain factors. Therefore we present these results in a progress report as they indicate the desirability of controlling open-hearth practice when certain types of plate mill steel are made.

The general investigation covers the practice on both low and medium carbon steel. In the case of the former type, complete data were collected on the open hearth and final inspection of fifty-eight heats. In the latter type, only the mill reports were available.

The defects occurring in plates which are attributed to the open hearth are blisters, scabs, snakes, and laminations. An idea of the relative importance of these can be obtained from the rejections on one rolling of fifty-three heats which were as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blistered</td>
<td>1.88</td>
</tr>
<tr>
<td>Scabby</td>
<td>1.11</td>
</tr>
<tr>
<td>Snaky</td>
<td>0.37</td>
</tr>
<tr>
<td>Laminated</td>
<td>0.24</td>
</tr>
</tbody>
</table>

No information was available on the FeO in the slag for this second group of heats, but it can be assumed that the FeO increased with the lime charge.

The fact that high FeO in the slag results in an increase in blisters on the finished plates indicates that the gas forming these blisters is owing to a reaction between carbon and oxides. This theory is supported by the decrease in blisters resulting from furnace and deoxidation practice which produce steel with a lower iron oxide content. Further work is being done on the metallographic characteristics of blisters and on oxides and possible gas forming reactions.

From the above results, it is apparent that a lower lime charge would improve the quality of plate mill steel with respect to blisters. This improvement could be accomplished without decreasing the pro-

| Table I
<p>| Relation between FeO in Slag, Lime Charge, and Blisters. (0.15-0.25 per cent carbon plate mill heats) |
|----------|-------------------------------------------------|----------------|----------------|-----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Lime charge</th>
<th>%</th>
<th>FeO in Slag—</th>
<th>%</th>
<th>Blisters</th>
<th>No. of heats</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.69 (8.00)</td>
<td>10.61</td>
<td>10.78</td>
<td>...</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>8.29</td>
<td>11.16</td>
<td>11.36</td>
<td>1.72</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>8.47</td>
<td>11.59</td>
<td>11.43</td>
<td>2.57</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>8.74</td>
<td>12.16</td>
<td>12.09</td>
<td>5.65</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

This investigation deals chiefly with the factors affecting blisters, as these appeared to be the most important defect.

The principal factors in open hearth practice which have been found to affect blisters in the finished plates are the lime charge and FeO content of the slag, the method of working the heats, and the deoxidation practice. In blooming mill practice, the yield from ingot to bloom is of considerable importance. These factors will be taken up in detail in the following parts of the report.

Effect of Lime Charge and FeO Content of Slag on Blisters

In the case of both low and medium carbon plate mill steel, it has been found that the blisters occurring in the finished plates are a function of the lime charge and FeO content of the slag. This relation for low carbon steel is shown in Table I.

This table was compiled from the data of 53 heats which were grouped in order of increasing blisters. As the per cent blisters increase, there is an increase in the FeO content of the slag, and likewise in the lime charge, with the exception of the first group. In this group the lime is exceptionally high for the FeO given, the normal lime for this slag composition being shown in brackets.

A similar relation between the lime charge and blisters was found in the case of the medium carbon steels. This is shown in Table III in conjunction with another factor—the per cent yield. The data from Table III are plotted graphically in Fig. 1.

Table II—Furnace Data on 0.35-0.45 per cent Carbon Heats (Not recarburized)

<table>
<thead>
<tr>
<th>Rolling</th>
<th>Per cent lime charged</th>
<th>Tons produced</th>
<th>Time charge to tap</th>
<th>No. of heats</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8.9</td>
<td>128.6</td>
<td>12</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>9.4</td>
<td>120.4</td>
<td>13</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>9.8</td>
<td>123.5</td>
<td>12</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>8.3</td>
<td>120.5</td>
<td>12</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>8.8</td>
<td>130.6</td>
<td>12</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>9.2</td>
<td>126.1</td>
<td>12</td>
<td>24</td>
</tr>
</tbody>
</table>
duction, as is shown by the tonnage and time data of Table II.

Effect of Method of Working Heats in the Open Hearth on Blisters

The .35-.45 per cent carbon plate mill heats were made by two types of practice. In the first type the heats were worked down to below .20 per cent carbon and then re-carburized to the desired specification. In the second the heats were worked down slowly and tapped at the specified carbon. A special deoxidation practice, consisting of the use of a combination of spiegel and 10 per cent ferro-silicon, was followed for both types.

The effect of these two types of practice on blisters is shown in Table III. The average lime charge in the non-re-carburized heats is higher, which would result in an increase in blisters due to higher FeO in the slag, as explained above. Consequently the per cent blisters on these heats has been corrected to 9 per cent lime, using a factor derived from Fig. 1. On the basis of the corrected values, the non-re-carburized heats show an average of .47 per cent less blisters than the re-carburized heats.

No data is available which will enable us to determine the effect of the deoxidation practice, as it was applied to all heats. It is probable, however, that this special deoxidation results in a decrease in blisters, as well as a product of more uniform analysis.

Relation Between Blooming Mill Yield and Blisters

It was noted that the blisters in plates increase with the blooming mill yield. This relation for the .35-.45 per cent carbon heats is shown in Table IV, and the same data is plotted in Fig. 1.

In order to obtain a more accurate determination of the rate at which blisters increase with increasing yield, this data was grouped and plotted on the basis of yield alone in Fig. 2. The line connecting the points is straight over the range covered by the available data. The continuation of the line is dotted, as the accuracy of this portion is questionable.

Fig. 2 indicates that blisters are only formed in the steel from the upper part of the ingot. In the case of the practice from which this data was obtained, only the upper 20.7 per cent of the ingot is subject to blisters. The slope of the line shows that an average of 40.6 per cent of the plates rolled from this upper portion will be blistered.

The question naturally rises as to whether the
steel from this affected portion can be profitably rolled into plates. If the value of the good plates obtained by working a portion of the yield above

<table>
<thead>
<tr>
<th>Lime charge %</th>
<th>Yield, ingot to slab %</th>
<th>Blisters %</th>
<th>No. of heats</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.40-8.79</td>
<td>81.0-82.9</td>
<td>0.88</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>83.0-84.9</td>
<td>1.58</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>85.0-86.9</td>
<td>1.51</td>
<td>8</td>
</tr>
<tr>
<td>8.80-9.19</td>
<td>81.0-82.9</td>
<td>1.08</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>83.0-84.9</td>
<td>1.74</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>85.0-86.9</td>
<td>2.22</td>
<td>20</td>
</tr>
<tr>
<td>9.20-9.59</td>
<td>81-84.9</td>
<td>1.81</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>85.0-86.9</td>
<td>2.63</td>
<td>12</td>
</tr>
</tbody>
</table>

79.3 per cent is less than the cost of working this portion, the operation will be conducted at a loss.

**Conclusions**

The results already obtained in this investigation indicate that the following practice would be advisable in making medium carbon plates:

1—The lime charge should be maintained as low as possible; the exact percentage will be governed by the phosphorus specification.

2—Medium carbon open-hearth heats should be tapped directly instead of being recarburized.

3—The per cent yield which can be worked at a profit will depend upon the value of good plates obtained from that portion above 79.3 per cent yield less the cost of working this portion.

### A Typical Coal or Producer Gas Flame for Steel Heating, with Natural or Coke-Oven Gas

(Continued from page 1221)

very heavy red haze, rather than the short bright flame produced with gas. Because of its slow burning characteristics it is possible to fill furnaces of very large volumes with a heavy protective flame.

By using a small combustion chamber, or firing over a bridgewall, it is possible to burn all of the hydrogen in the combustion chamber and carry only molecular carbon over into the furnace proper. This produces a flame of a lower temperature, but of a dense radiant character, which transfers its heat directly from the flame to the work by radiation. By transferring heat by radiation from the flame itself it is possible to obtain even faster heating with a lower flame temperature than is possible in transferring heat by convection from a clear flame of higher temperature.

Lower flame temperatures mean less oxygen from dissociation of CO₂ and H₂O. By using a lower flame temperature it is also possible to eliminate hot corners and edges in pack heating.

Controlled luminous flame combustion has made it possible for the steel man to use natural or coke oven gas for the production of higher grade sheets, and in many cases has shown real fuel economies, which in most cases were owing to faster heating furnaces. These gases have always been considered ideal from the standpoint of control and ease of handling, but have heretofore been handicapped because of the rash heat which they produced when burned efficiently. The fact that these gases can now be burned at the maximum of efficiency and still produce an ideal condition for heating steel makes them the ideal fuel for steel reheating.

### Steel Sheet Specifications Approved

**THE American Standards Association has just approved American tentative standard specifications for zinc coated (galvanized) sheets of Bessemer steel, open-hearth steel, and open-hearth iron. Five classes of zinc coatings, applied by the hot-dip process, are covered in the specifications, as follows:**

**Class A**—Extra heavily coated sheets that are not intended to be formed other than by corrugating.

**Class B**—Heavily coated sheets that are not intended to be formed other than by corrugating and curving to large radii.

**Class C**—Moderately heavily coated sheets for moderate bending.

**Class D**—Ordinary coated sheets for general utility.

**Class E**—Sheets having lighter, more tightly adherent coatings to reduce liability of flaking in severe forming.

Class D coatings approximate those of Class C except in medium gages in which coatings of Class D are appreciably lighter. Class D represents material generally available in warehouse stocks which is not intended for use where relatively long life, represented by Classes A, B, and C, or severe forming, represented by Class E, is required.

The standard includes sections dealing with chemical properties and tests, physical properties and tests, base metal tests, coating tests, permissible variations, finish, marking, and inspection and rejection. Provisions for minimum requirements when copper is used in the base metal, requirements for weight of the zinc coating including a table of weight of coatings by ounces per square foot, provisions for base metal tests, coating tests, and weight tests, and a table showing gage range and permissible tolerances in weights of sheets in percentage of theoretical weight are included in the standard.

The standard was submitted to the American Standards Association by the American Society for Testing Materials, sponsor of the project.

Copies of the standard may be obtained from the American Standards Association, 29 West Thirty-ninth Street, New York City, at 25 cents each.
The Handling of High Grade Sheet Steel

By EDWARD S. LAWRENCE

PART II

The second grouping of sheet handling patents will be discussed in operative detail. The first grouping comprised inventions pertaining to the handling of high-grade sheet steel while being processed through the mill (Part I). This second grouping includes handling apparatus for loading high-grade steels, strip, etc., into either open or closed railroad cars, its method of conveyance and methods of unloading with minimum labor and time.

Within the past few years a great deal of time and attention has been given to the study and elimination of manual handling of sheet metals. It has been, and in many cases still is, common practice to load sheets by hand truck into box cars. Two men standing at opposite ends of a truck thus transfer and stack the sheets by removing a few sheets at a time. The usual load in a box car consists of 40 tons of sheets divided into four equal piles, one in each corner. Such a car loading usually requires about four hours for four men with two trucks. The manual handling of such material is slow since the sheets are oiled to prevent rusting, and it is dangerous as the sheets have sharp sheared edges and are hard to handle. The development of apparatus to eliminate manual handling and also the handling of these large piles of sheets as a unit, is both labor and time saving to say nothing of the advantage of moving a great many cars in a day on a limited amount of available trackage.

Stahlhut Patent

With these facts in mind we find the Stahlhut patent No. 1,708,854 of particular interest as it describes an apparatus for handling large piles of thin gage sheets as a unit. This invention is set forth in Fig. 1.

The apparatus comprises a movable truck having a receiving platform with a large number of rollers on its upper side, a plow or wedge also having rollers on its upper and lower sides and a power-actuated means for pulling the stack by a relative longitudinal movement over the wedge and onto the truck platform. The truck is provided with castors, so that it can be easily moved. The means for pulling the stack of sheets onto the truck consists of a cable looped around the pile, which is pulled back towards the truck as the cable winds onto brake drums.

In operation, the loaded car is brought alongside a landing platform and a bridge is placed over the space between the doorway and the platform. The blockings for the stacks are removed so that space will be left entirely around them. By means of a crowbar the front end of a stack is slightly raised and the sharpened end of the plow or wedge inserted. The truck is then moved into position where its rear end squarely engages the thick end of the wedge. The back plate is then put in place and the loop or U-shaped cable is slipped over rear end of the stack and lodged in suitable notches in the plate. The motor is then started and the winding drums wind up the cable, both drums winding up equal amounts of cable. At the start the wedge is forced under the stack, the latter remaining in its fixed position for the reason that the friction of repose of the sheets lying on the floor of the car is greater than that exerted by the wedge. While this is taking place the truck and wedge are moving toward the rear of the stack. Finally, a point is reached where the friction exerted by the sheets on the floor is materially reduced and the stack begins to travel up the plow onto the rollers on the upper surface of the truck platform. While this latter is going on, the truck and plow remain stationary.
After the stack is properly loaded in the truck the latter can be moved by a tractor or equivalent means. As it is unnecessary to move the plow with the truck it is simpler to make it a separable piece. This arrangement also has the advantage that the plow can be placed under the front end of a second stack while the truck is moving its load to the point of discharge. The angle of inclination of the roller supporting members of the platform is such that just as soon as the cable is released the stack will start moving rearward and off the rear end of the truck.

The discharge of the load is controlled by the brake mechanism to prevent too rapid relative movements of the truck and load. Prior to releasing the load, a couple of spaced crossbars are laid on the floor for the stack to rest on. The bars will hold the stack above the floor to permit the insertion of two pairs of hooks by means of which the stack can be handled by a traveling crane. For unloading it is unnecessary to use the plow but it can be used if desired for any reason. As soon as the steel is on the floor at the rear end, the tractor or other means pulls the platform from under the stack, the relative difference in friction between the part on the floor and that on the truck permits this action.

The inventor claims that with this machine two men can load or unload in one hour the equivalent of four men working four hours. In other words, there is a saving equal to the difference between two man hours and sixteen man hours in unloading (or loading) a carload of sheet steel, to say nothing of the likelihood of developing defects such as pitting, scratching, or destroying the high finish of the sheets if manually handled.

**Romine Patents**

The Romine series of patents claim certain methods of transporting and unloading (or loading) large shipments of highly finished and oiled sheets, strips, and bars. Patent No. 1,745,057, as illustrated in Figs. 2 and 3, describes the piling of large metal units whereby resistance to the relative sliding or shifting movement of the parts of the pack during transit is set up through the medium of friction material causing a binding or frictional action on the parts within the pack or within the cross-sectional area.

Thus, as illustrated in A (Fig. 2), four different rod or bar shapes are bound together. These rods are built up in layers and between each layer is interposed a friction material (100) such as soft wood, fiber board, etc. After the desired number of layers of bars or rods with the interposed friction material have been built up to the desired size the pack is bound together as a unit.

This is accomplished as shown in Figs. 2 and 3 by enclosing the pile by rigid steel yokes or frames E. As shown, two or more such frames are utilized. The frame carries a series of screw pressure devices indicated as II in Fig. 2. Interposed between the pressure devices carried by each binder frame or yoke and the pack are soft wood or fiber strips. Thus, when the pressure devices II are tightened both from the top and sides of the frames considerable inward and downward pressure is created which, together with the layers of frictional material and the weight of the pack itself, tend to hold the pile rigid in transit.

In B, Fig. 2, narrow strips are held in place by soft wood ends. This pile is bound as described, and while no frictional layer is interposed, the sharp sheared edges of the strip cut into the soft wood and together with pressure exerted by its own weight, and with retaining pressure through pressure screws, the pack will tend to move very little in transit.
In C, Fig. 2, is shown the invention in connection with packs of sheet metal, or relatively wide strip metal, wherein the sheets or strips are of different sizes and are positioned flatwise. The pack is bound together by means of binders E. The wider sheets C are first placed upon the angles 15, after which one group of narrower sheets A' as desired are stacked flatwise upon the top of the sheets C. A series of wood strips or bars 16 are placed against the inner edges of the group or stack of sheets A' and thereupon another group or stack of narrower sheets B' may be placed upon the top of the pack C with their inner edges abutting the friction material 16. The requisite number of sheets forming the groups or sections A' and B' are stacked flatwise one above another until a pack of the desired size has been formed. Thereupon the pack is bound together by means of the binders E carrying pressure devices 11. Interposed between these pressure devices and the outer edges of the sheets at one side is a friction wood strip 17. In this instance the pressure devices at the opposite side of the binder are omitted, and the binder itself is drawn into engagement with a wood strip 18 when the pressure devices at the opposite side are tightened. In this manner the wood members 17 and 18 will be forced under pressure against the edges of the sheets in the stacks A', B' and C. Furthermore, the inward pressure exerted by the binder against the stacks or layers A' and B' will result in forcing the inner edges of the sheets into frictional engagement with the material 16, resulting in an imbedding action of the edges of the sheets in the wood or frictional material.

For the most part, the various kinds of material piled as shown and described in Fig. 2, rest on the car floor and is spaced apart from it by supports 14 (Fig. 3). These wood members or riding supports are secured together by means of longitudinal wood members which are secured to the car floor and prevent lateral shifting of the pile in transit. The longitudinal movement is prevented by frictional layers between material and pressure screw clamps and the yokes.

Thus to summarize the above invention, the inventor has provided a method and apparatus whereby sheet, strip and bar metal may be transported in freight cars or carriers while minimizing the tendency of the metal parts to shift or break loose from the bundles or packs. The internal friction which is applied to the metal parts is obtained through the medium of relatively softer material than the metal. On account of the fact that some variations usually occur not only in the width of the sheets, but also in the size of the bar or strip stock, particularly where the mills are allowed a slight percentage of variations, the binding action between the friction material and the metal is increased. The slight irregular surfaces of the metal, at the edges or corners, will cause the friction material to be embedded therein. This effects a clamping or binding action between the friction material and the metal, thereby resisting relative movement of the sheets, strips of bars during transit. When the car is subjected to a shock or blow, the inertia of the pack will often overcome the frictional resistance between the supporting members, causing the pack to shift longitudinally. The impact against the car, however, will not result in the sheets, bars, or strips shifting any substantial distance within the pack since the frictional resistance internally of the pack, as well as externally, between the metal and the frictional material will be greater than the frictional resistance between the supporting members and the car floor.

**Apparatus for Shipping**

Another Romine patent, No. 1,784,909, embodies methods and apparatus for shipping metal and is a continuation of the Romine patent described. This patent, shown in Fig. 4, embodies the essential features of unit piles already detailed. It leaves out, however, the internal non-metallic frictional layers between the material and resorts to piling of smaller units or packs wherein the sections or layers are maintained together through a common external medium for frictional resistance. It, of course, further maintains the individual stacks of any section together through frictional metal resistance within the cross sectional area of the bundle as a whole.

Referring to Fig. 4, views A and B show the metal sheets or strips as arranged in layers or groups in its successive steps of loading on a car floor.

The pack of A comprises a bottom layer D, the individual sheets or strips of which are disposed on edge, and a top layer or group D', the sheets of which are arranged similarly to the sheets of the lower group or layer. The two layers or sub-units which make up the entire pack or larger unit may be bound as shown in A, at the mill prior to loading in the car, or the pack may be bound in the car. However, it is preferable to form the pack at the mill so that it may be taken as a unit into the car,

(Continued on page 1232)
Hair Cracks on the Surface of Sheets

By ERICH A. MATEJKA
Dipl. Engr., Witkowitz

PART III

SPECIAL care was taken in the investigation of sources of the defect on casting the steel. Pacher describes extensively the large number and the importance of these sources of the defect. A. W. and H. Brearley also have tried to make use of the effect of casting conditions on the development of the primary crystallization in order to explain the red-shortness of steel. By means of examples they show that the appearance of segregations and separations of non-metallic intermediate substance at the crystal boundary is greatly facilitated by the formation of radiating crystals on the solidification of a steel ingot. Therefore they regard the presence of radiating crystallites in a steel ingot as one of the most important causes of the red-shortness of the material during hot-working; this also because the elongated planes of separation of the individual crystals, generally unfavorably placed with respect to the direction of the stress, can cause a reduction in the strength of the ingot surface under certain circumstances.

The Casting Temperature and Rate

Barba and Howe summarize the essence of American foundry practice in the rule "melt hot but cast comparatively cold." In their opinion casting temperature and rate of casting must be carefully selected in order to avoid two dangers—external cracks in the ingot caused by too hot or too rapid casting, and external roughness as well as the amount of inclusions can be increased by too cold casting. Oberhoffer also emphasizes the extraordinarily great importance of the relation of casting speed to casting temperature.

In order to test the effect of the rate of casting, individual tests were made in addition to the large experiment.

Heat 9942 (0.13 per cent C, 0.52 per cent Mn, 0.032 per cent P, 0.026 per cent S, 40.9 kg. strength and 22.0 per cent elongation). The temperature of this heat was as usual, and was cast as follows:

The first set was poured very slowly (casting time 12 minutes).
The second set was poured as usual (casting time 8 minutes).
The third set was poured very rapidly (casting time 6 minutes).

After casting the third set it could be observed that the ingots differed from the others in not having sunk as usual, but instead having risen somewhat. In order to be able to observe the effect of the rolling temperature at the same time, half of the ingots were slightly heated and half were heated properly. The ingots from the first set were the best, comparatively speaking; while the ingots from the last set were the worst. As regards the quality of the surface, the blooms from the second set were similar to the blooms from the first set, and this is proof, assuming the ordinary casting temperature, that the ordinary rate of casting is correct.

In connection with these experiments, the ingots from the second set in 60 heats were cast somewhat more rapidly than those of the first and third sets, in which the usual rate of casting was maintained. Just as in the individual experiments, the usual rate of casting was maintained. Just as in the individual experiments, the ingots cast slowly, that is, as usual, were better, but the difference in yields was not great enough for the rate of casting to be considered the cause of the defect.

Fig. 11, which shows the result of the large-scale experiment, compares the heats poured with the full stream (rapid casting) with those with a restricted stream (cast as usual). However, the casting temperature as such was not tested for its effect, since, aside from the difficult determination of the true temperature, the temperature on one hand and the velocity on the other hand in themselves do not determine the result of the casting, but the choice of the correct ratio does. The large-scale experiment showed a noteworthy result. The heats poured with a full stream showed a better yield of sheets with good surfaces than did those cast as usual. This result, however, must not be misinterpreted. The nine heats poured with the full stream...
are compared with 359 heats poured as usual. In itself this is a disparity that disturbs the comparison and is also proof of the exact work of the steel furnace operator, that is, in getting the proper temperature. In the second place, the nine heats cast with the full stream were not arbitrarily cast rapidly, but it was necessary because they were colder and required faster pouring. The result of the large-scale test is thus merely proof that, taken by and large, the extremely important ratio of casting speed to casting temperature was correctly chosen for successful casting.

**Fluidity of the Steel**

Sometimes there were heats whose fluidity on pouring was not as usual, but was thick. The cause could not be determined directly, but experiments are under way. On the basis of previous investigations it can only be stated that neither the temperature nor the manganese and silicon content of the heat made it viscous. According to Oberhoffer, viscosity prevents the escape of gases during solidification, so that the inside of the ingot is full of blow-holes. Naturally the presence of air bubbles is detrimental to the strength of the ingot, as it suffers greatly from the discontinued coherence of the material.

In order to be able to study the effect of viscosity on the position of the edge blowholes and solidification pores, ingot 11 of heat 557 (0.24 per cent C, 0.54 per cent Mn, 0.025 per cent P, 0.042 per cent S, 47.0 kg. strength and 20.0 per cent elongation) which showed this phenomenon on casting, was removed before charging the reheating furnace, and then broken longitudinally. Fig. 12, which shows the fracture of this ingot, proves that it has a sound edge but shows a very pronounced region of edge blowholes at the surface. With such ingots, if they are allowed to weld together on heating in the reheating furnace as usual, there is the danger that the blowholes immediately below the surface will be laid bare and thus cause the formation of cracks.

This danger can be overcome if they are heated carefully and not allowed to sweat, that is, if there are avoided large burning losses, which in themselves reduce the weak parts of the ingots. The justification of this assumption and the proof that sound-surface blooms or sheets can be produced from ingots heated in this manner, which are made denser by suitable roughing, can be seen from the results of the following experiment:

Ingots 1, 2, 3 and 4 of heat 557 were carefully preheated and the others were allowed to sweat. Three of the blooms from the first four ingots had sound surfaces and one had slight cracks at the edges. The blooms from the other ingots were more or less full of cracks.

On the basis of this test result it was arranged that heats that are viscous on pouring must be well and uniformly heated, and must be drawn in the layer of scale. The result of the large-scale experiment on the average yield of sheets with sound surfaces in ordinary and viscous heats confirms the success of this precaution.

**Molds**

(a) Shape and wall thickness. According to Oberhoffer, under otherwise equal conditions the wall thickness of the mold is a measure of the rate of solidification. Oberhoffer and Weissgerber have found that with a wall thickness of 12 mm. extremely fine globular crystals form, which change to obvious dendrites with increasing wall thickness. The great influence that the wall thickness of the mold exerts on the development of the cast structure is thus proven. This is confirmed by others, particularly by Oertel and Richter, who were able to prove that the thickness of the region of radiant crystallites depends on the rate of heat conduction by the mold. According to Eilender, the structure of the ingot can be extensively influenced by suitable selection of the wall thickness in relation to the ingot cross section and the growth of coarse acic-
ular crystals will be suppressed by the correct ratio of wall thickness to ingot cross section. This is very important, as the hot plasticity is greatly reduced by the appearance of such crystal formations. Jef- fries and Archer also show the extent to which the development and size of crystal units or grains depend on the conditions that prevailed during solidification, and which in turn are influenced by the casting temperature or by the heat conducted away. A. W. and H. Brearley, in addition to the effect of casting temperature and rate of casting, also assume an effect of the cross section of the mold and its thickness, on the transcristallization. But according to their experience it is not correct to prefer thin-walled molds because of the formation of a sufficiently thick crust that restricts the transcristallization more should it form faster. F. Leitner prefers medium walls as they give a better crystalite formation and almost equal solidification periods. It must be observed, however, that in his investigations Leitner only used small ingots, the largest being 250 mm. in diameter.

This shows plainly the great influence of the wall thickness of the mold on the development of the cast structure. Since this is very important in practical work because of its effect on the hot workability of the material, the appearance of the surface defect on ingots cast in molds of different shapes was studied closely. There was more reason for closer investigation here, as it was observed frequently that in the same heat the end ingots cast in molds I and III were good even when sheet ingots from mold X showed surface cracks on rolling.

In order to be able to test perfectly the effect of the shape of mold on the occurrence of surface cracks, heat 323 (0.17 per cent C, 0.53 per cent Mn, 0.042 per cent P, 0.016 per cent S, 45.7 kg. strength and 21.5 per cent elongation) was used, and the first and third sets of molds were the usual ones for sheet ingots X, while the second set had molds with different wall thicknesses. All the ingots were heated at the same time and rolled to the following bloom cross sections under exactly equal conditions:

- Ingots from first and third sets—900 by 160 mm.
- Ingots from second set—Ingot X, 900 by 160 mm.
- Ingot VIII—900 by 140 mm.
- Ingot V—700 by 120 mm.
- Ingot III—500 by 160 mm.

In order to be able to study accurately the surface blooms from the second set, they were laid aside after roughing and allowed to cool. In Fig. 13 there is shown the original cross sections after roughing, and the distribution of cracks on the surfaces of the blooms rolled from different shapes of molds. The surface of the blooms from the sheet ingot X and ingot VIII was most strongly cracked. The bloom from ingot V was less defective at the edges, and the bloom from the rectangular ingot III was practically sound, even as regards traces of cracks.

If, considering the earlier statements on the ratio of mold wall thickness to ingot thickness (which determines the structure of the casting) we compare the ingot shapes, we reach the following noteworthy result:

<table>
<thead>
<tr>
<th>Ingot</th>
<th>Wall Thickness to Ingot Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1:3.0</td>
</tr>
<tr>
<td>VIII</td>
<td>1:3.4</td>
</tr>
<tr>
<td>V</td>
<td>1:3.7</td>
</tr>
<tr>
<td>III</td>
<td>1:4.7</td>
</tr>
</tbody>
</table>

The ratios (wall thickness to ingot thickness) of the different kinds of molds increase in exactly the same order as the decrease in the appearance of the defect on the corresponding ingot shapes. Since the ingots were cast at exactly the same temperature and at the same rate, and were poured under equal conditions, such an essential difference in the development of the cast structure of the different ingot shapes can be assumed that a noticeable effect on the hot workability results.

In order to test the result of the individual experiments described above, square molds III instead of mold X were used on the second set in two other heats similar to the above. In four more heats a mold X on each set was replaced by mold III. The ingots then were thoroughly heated and rolled, with the following result:
Of 20 ingots (III), 15 or 75 per cent had sound surfaces. Of 52 ingots (X), only 29 or 56 per cent had sound surfaces.

**Shape of Mold Important**

Thus the result of the first experiment is confirmed. The same result was also obtained (Fig. 14) in the corresponding large-scale experiment which compared the average yield of blooms with sound surfaces, sheets, and the tensile test-pieces from material rolled from the ingots III or X. This experiment was the only one in the whole series that showed perfect agreement of observations in the ingot rolling mill, the sheet mill and in the testing laboratory. This is additional proof of the great influence of the shape of mold on the appearance of the surface defect.

But as the defect appears on sheets (although not to the same extent) that are rolled from ingots of the most widely different shape and therefore with correspondingly shaped molds, it can be concluded with certainty that the true cause of the defect must be sought elsewhere. According to Certel and Richter,\(^\text{22}\) the radiating arrangement of crystallites in a steel ingot (as might be the case with ingots giving poorer yields) is not alone of decisive importance in its hot plasticity. They have shown this by the fact that they could remove the transcrystalline zone by turning (on a lathe) two ingots from one heat which rolled badly. The action of these two ingots on rolling was just like the other ingots from the same heat.

Later we shall discuss the extent to which other influences can explain the different action of ingots III and X on rolling.

(b) The radius of curvature of the corners of the mold. On the basis of the observation that the cracking of the surface of the ingot on rolling was always seen first at the edges, the shape of the corner of the mold was also taken into consideration.

As reported by A. W. and H. Brearley,\(^\text{34}\) the solidification of the steel in the shape of the ingots starts at the corners, and the crystals in and at the corners always remain small because of the rapid cooling. But the corners, as end points of the diagonals representing lines of minimum strength, are points of low strength. The diagonals are contact lines between crystals that grow in different directions in relation to each other, and are points of planes that solidify one after the other. The planes formed by them are rich in segregations and non-metallic impurities. They are filled by elongated gas holes and are also found at places where there are small voids caused by stress on contraction. A large part of the lower strengths observed along the diagonal planes is because of the effect of these segregations and voids formed by contraction. But it was impossible for Brearley to determine the extent to which the lower strength is due to crystal arrangement only.

In order to study the relations between the shape of the corners of the mold, which certainly fixes the crystal arrangement and the cracking of the edges of the ingot on rolling, heat 9964 was used (0.09 per cent C, 0.51 per cent Mn, 0.030 per cent P, 0.021 per cent S, 36.8 kg. strength and 30.5 per cent elongation). The first and third sets had the ordinary molds X, but on the second set there was a mold IX with the same wall thickness but with a greater radius at the edges and therefore having less sharp corners. In order to be able to study the effect of the rolling temperature at the same time, the ingots from this heat were put in two reheating furnaces, one batch being heated strongly and the other mildly. From the viewpoint of the shape of ingot, the blooms with the more rounded edges IX were all good after roughing, while edge cracks were found in the three ingots X.

As the ingots were cast under otherwise equal conditions, it must be assumed on the basis of this result that the shape of the ingot edges has some effect on the action during hot working. For this reason the radius of curvature of the corners of the ordinary mold X for sheet ingots was increased from 65 mm. to 100 mm.

(c) Cleaning the mold. According to Oberhoffer\(^\text{35}\) and Pacher,\(^\text{36}\) improper cleaning of the mold may cause the formation of local blowholes because the carbon in the steel causes the evolution of carbon monoxide with the impurities containing ferrous oxide, which comes from rust or from the last casting.

In order to test the effect of these impurities on the quality of the surface of the blooms, great care was paid the cleaning of the molds. Supervision was intensified and the number of mold cleaners was doubled. Thus we were sure that only perfectly cleaned molds were used during the time of the experiment. During this time also, any damaged molds were removed in advance, as usual. According to these investigations, covering 6384 blooms, the degree of cleaning of the molds has no effect on the formation of surface cracks or, to word it better, the ordinary method of cleaning is sufficient, so that any mold scale remaining after the cleaning has no appreciable effect. This was also confirmed by the result of the large-scale experiment.

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**Fig. 14**—Effect of shape of molds

- **Oblateness** = shape of mold
- **Solid line** = yield of good blooms in per cent
- **Short dash** = frequency
- **Dot-dash** = yield of sound tensile test-pieces in per cent
(d) The character of the mold wall. According to Pacher, rough mold surfaces, and especially local cavities, can result in the retention of the gases contained in the steel in the beginning, and thus cause the formation of local blowholes. He also mentions the injurious effect that may be caused by defective places on the surface of the mold, in that they offer resistance to the steel during contraction and thus produce a loosening of the structure in the ingot.

To see the extent to which irregularities in the walls of old molds may affect the crack formation, was made the object of the following experiment: In a rather large number of heats (74 in all) an old mold was on the right of each set, and a new mold with perfectly smooth and perfect walls was on the left, and then the casting was done as usual. The result of the experiment justified the conclusion that the cracking of the surface of the bloom is independent of the character of the wall of the mold. The ingots cast in the new molds were somewhat better, but the difference was not striking.

(e) Temperature of the mold. A. W. and H. Brearley assume that the mold temperature exerts an influence on the growth of the transcrystalline zone. Pacher states that cold molds would aid the tendency for the cast ingot to cool more quickly and to solidify more rapidly, but the use of cold molds that are not dried involves the danger of moisture, as the water vapor in the air deposits on the walls, entirely aside from the fact that cold molds crack easily. According to Pacher, moist molds result in the formation of blowholes at the surface of the ingot.

In order to investigate the effect of the mold temperature, 77 heats were cast as usual except that on the right of the gate there were perfectly cold, to hot, very hot, and extra hot, heated) were on the left. No effect of mold temperature on the formation of the surface defect could be determined on roughing.

References

28Ioc. cit., p. 326.
29Ioc. cit., p. 327.

(The to be continued)
Efficiency Court for Accident Prevention

A novel means of bringing about safe practices, in which a judge, a jury, and lawyers consider each accident

By H. M. Crooks

In the industrial plants of today, when a piece of work is ruined or a piece of equipment is broken, an investigation is immediately started by the foreman to discover the reason and to decide on the means of correction or penalization, if necessary. Practically every large industrial organization spends huge sums of money each year in machinery changes, new methods of doing work, etc., in order to increase efficiency, which in turn increases production and decreases costs.

Most manufacturing plants which produce either finished parts or finished commodities as a whole for the market, have in their organization an efficiency or production manager who devotes his entire time to efficient production. One duty, and the most important, of the efficiency or production manager, is to train his organization to produce in the most efficient manner with the equipment available, which means operating equipment, and the proper routing and handling of material. This in turn means training the mind of the workman to function to the highest capacity.

All such plants also have another organization acting entirely as a separate unit, a safety organization under a separate manager, known as safety director. In most cases these managers are not picked from the men who have been trained along the lines of production. The safety director’s duties are to build up a safety organization and drill it along an entirely different line and an entirely different thought, which is accident prevention. His methods as a rule consist of lectures, bulletins, slogans, advertising and competitive campaigns. While all this is going on, the mind of the workman is entirely divorced from the efficient production thought that is being drilled into the mind by the production manager. The mind of the workman, therefore, is traveling along two major thoughts which in a way must conflict more or less.

Safety First

Let us consider just what “Safety First” means. It must mean accident prevention as this is the result sought. Accident prevention is doing work in the most efficient way. An accident is the result of doing a thing which should not be done. Efficiency is the result of doing what should be done.

A place is seen cluttered up with materials and tools laying around. The safety manager thinks someone will be injured; the production manager asks how a man can produce with all that interference. A machine with gears is exposed. The safety manager thinks of someone getting caught; the efficiency manager thinks something will get in the gears, crippling the machine, or that the operator will get caught, thus stopping the production of that machine and mind. A mine roof caves in, the safety manager thinks of someone being careless; the operating official thinks of the delay, the added expense, and the disorganization of a continuous flow of material because someone was inefficient in the performance of certain duties.

The slowing up of the working power of a man is noted immediately by the production manager, and the cause is located and either corrected or the man is changed until he is back to normal. The safety director does not know there is anything wrong until through abstraction the man is injured. The production manager is alive to every change of any kind, as it retards production, but the safety manager is not, as he is not versed in the line of procedure.

The safety director has in his organization a welfare worker who keeps him informed as to the conditions that surround the workman when away from the factory. This gives him a chance to anticipate reactions. The efficiency manager should have this information just as he should know that the equipment is functioning correctly.

The production manager insists that everything must be in order, that tools must be kept in the proper place, that materials must be handled in proper manner, that interference must be eliminated, and that every movement must count. He checks his men as he does his equipment so that each performs in the most efficient manner. He allows nothing to interfere and insists that the mind of the workman must be on what he is doing so that there will be no false move or loss of time. These are the
very things, as far as accident prevention is concerned, that the safety organization is fighting for, but its method of fighting is different in that it takes the workman's mind away from the task, which decreases efficiency and increases hazards, for the reason that his mind is on accidents which are not there if his mind is on the task in an efficient manner.

The production manager must drill the minds of his workmen on every angle that pertains to efficient production. He must be alert to all conditions; he must drill this into his organization, and he must investigate every delay, the cause and results. He must analyze every false move and he must get this information to his organization.

This brings us to the description of the title of this article.

In searching for a means of bringing to the minds of our organization the cause of accidents and their effects on production, we decided that in order to get all information pertaining to an accident and to inefficient action and thinking, the best way would be a series of questions, directed in a way that would bring out the record of a man's work—the frequency of delays for which he was responsible and the manner in which he did his work. Questioning the foreman as to the man's ability and record, everyone that saw the accident, men who had performed the same class of work before, their methods, etc. was our line of procedure, so as to throw all the light possible on the particular occurrence. This could be done, of course, in our office, but then we would have to report the information to the rest of the organization, which would require extra time and would not be efficient in time saving. It also gives rise to the thought that might occur to the organization that some of the information handed out was a trifle stretched for effect. How, then, to get the direct information to the men?

**Efficiency Court**

We decided upon an efficiency court. We were to try each accident, not with the thought of entertainment at the expense of the injured, but to prove two things: First, that accidents are the result of inefficiency; and second, to bring out the loss of time, slowing up of production and the added cost. To put this system into effect required some thought. To place a man before a large body of fellow workmen and question his inefficient way of working was somewhat of a change from the common practice, and in order to get the full benefit of the plan, it was necessary that we get the men to see just what we were trying to accomplish. This was done through a personal talk at our first general meeting.

In order to carry on any serious undertaking, one must be fair. One must recognize the conditions under which the thing occurred and be ready to comment on the good qualities as well as the bad and eliminate all danger of fun or ridicule. It must be conducted on an absolutely fair and business-like basis, with the backing of the management.

In our organization, a court was formed under these conditions. We appointed a prosecutor and a defense attorney who act under regular court procedure and under a presiding judge. The reason we appoint the attorneys is because we must have men who are serious, who will follow our line of thought and questions in order to get the true information we desire and who will not in any way ask questions that will lead to or suggest ridicule, and who will ask all questions in a manner that will cause the least embarrassment to the witness possible. The defense attorney has a rather difficult task. He must not in any way try to prove the method of work was right, but must base his defense entirely on the condition of the man physically or mentally, the thoroughness of his instructions and the condition of equipment or the inefficiency of the men working with him. At no time is there allowed any false evidence from either side. All men of the department are required to attend these courts. The jury is picked from workmen in the organization. No foreman is allowed to act as a juror. Each case is tried under a separate jury. This jury is composed of men who thoroughly understand the working conditions, and the line of work and equipment.

After all the testimony has been given, the judge calls attention to the main facts on both sides. He instructs the jury to thoroughly discuss the evidence presented and in making their decision to return with it any suggestions they have in mind for correcting that particular piece of work. The jury retires to a room by themselves, where there is no foreman who might act as a check on their discussions. While these discussions are going on, we have the minds of twelve experienced men centered on one problem, which not only brings out many wonderful suggestions, but actually trains their minds along the line of efficient thought.

**Illustration**

Let us illustrate just one accident. In doing a certain piece of work which required three men, one man received a badly crushed finger. The prosecution tried to prove that this man was a careless, inefficient worker, inasmuch as this work had been done many times before without an injury. The defense claimed that he was an efficient worker because he had done this piece of work many times with inefficient equipment and had not received an injury before, and that he was going to prove that the supervision was at fault in demanding the work to go on in this inefficient manner. Although there were several witnesses, the defense called just two—the injured man and his foreman. He asked the injured man two questions: First, whether he had been properly instructed in the way to do the work; and second, whether he understood the instructions. Both were answered in the affirmative. In questioning the foreman, he brought out the fact that the foreman had instructed the man thoroughly, that the method required three men fifteen minutes to do the work. He asked the foreman if it could be done in less time. The answer was, "Not with the present

(Continued on page 1239)
Uniformity of Quality in Coking Coals*

By RALPH H. SWEETSER

PART II

The test was divided into three periods as to groups of coal shipments, and also as to the three different mixtures of 85 per cent, 80 per cent, and 75 per cent West Virginia coal in the mixture charged into the ovens. The first lot of coal was so irregular in ash content that the chief chemist in charge of coal inspection and sampling was sent to the coke plant to investigate the complaints and to find out why the ash reported at the coal mine was about 1.60 per cent less than that reported at the coke ovens.

The first irregularity acknowledged by the chief chemist was that cars were not sampled separately at the mine, but in groups of three to six cars for a daily sample of each grade, so that individual cars cannot be compared. He found at the coke plant that in taking samples of coal after breaking down to 3-in. size, a shovel was inserted in an opening in the boot so as to catch 12 shovelfuls from each car; but the shovel was so wide that it had to be tilted about 45 deg., and in withdrawing part of the larger lumps rolled off, and these are usually lower in ash. This was corrected and a car of lump was sampled and the prepared samples divided and one part analyzed in the coal laboratory and the other at the coke plant; the coal chemist reported 5.20 per cent ash and the coke chemist 5.34 per cent. A sample of egg coal was handled in the same way; the coal chemist reported 8.20 per cent ash and the coke chemist 8.34 per cent.

The chief chemist for the coal mine called attention to the comparative regularity of the daily average of the ash in the coke for nine consecutive days, the maximum ash for a day being 1.14 per cent higher than the minimum and only .42 per cent higher than the average. However, he recommended that more slate pickers be put on the picking tables. He further reported that some slate was in the lump coal and that there was no excuse for this on the part of the pickers. The bone appeared to be more in evidence than in tipples inspection. This is owing to the cars inspected having been out in the rain and the bone being washed clean of dust and more readily detected. Much of the time the coal comes over the tipples damp or wet, with more or less coal dust adhering.

Possibly you men are thinking that I am going too much into detail with rehearsing all these alibis, but I want to bring out the fact that uniformity and average are two entirely different things, especially in coke oven and blast furnace operations. If the spread between minimum and maximum percentages of ash, sulphur, and moisture in coking coals is considerable in spite of a fairly satisfactory average analysis, the results in the blast furnace will not be as good as when the average percentages are higher but the highs and lows are close to the average.

During the first period of seven days the moisture in the coal mixture and the ash and sulphur varied as shown in Table IV.

<table>
<thead>
<tr>
<th>Table IV—Extremes in Coal Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
</tr>
<tr>
<td>%</td>
</tr>
<tr>
<td>Ash</td>
</tr>
<tr>
<td>Sulphur</td>
</tr>
<tr>
<td>Through 3/8 in.</td>
</tr>
<tr>
<td>Coking time, hours</td>
</tr>
</tbody>
</table>

The furnace used this first week coke with results as shown in Table V.

<table>
<thead>
<tr>
<th>Table V—Extremes in Blast Furnace Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
</tr>
<tr>
<td>Tons pig per day</td>
</tr>
<tr>
<td>Coke per ton pig, pounds</td>
</tr>
<tr>
<td>Daily average silicon, per cent</td>
</tr>
<tr>
<td>Daily average sulphur, per cent</td>
</tr>
<tr>
<td>Actual yield of burden, per cent</td>
</tr>
<tr>
<td>Average blast temperature, deg.</td>
</tr>
</tbody>
</table>

Second Period

During the second period, the coal mixture was 80 per cent West Virginia and 20 per cent Pocahontas. The extremes were as shown in Table VI.

The coke sent to the blast furnace during this period was reported to be better than that shipped the first week, but was not good enough and the burden was reduced a little. The blast furnace inspection reports contained such remarks as follows:

---

*Presented at Midwinter meeting of the Eastern States Blast Furnace and Coke Oven Association, Pittsburgh, Pa., February 13, 1931.
"The coke shows some improvement—still not hard enough and coke appearing to come from ovens not up to proper temperatures."

"Coke shows improvement, but still too much soft black ends and lump undercoked; size more uniform throughout."

"Coke small size and black ends"—"Very good coke (Feb. 9th); well burned but still has more soft black ends than in Freeburn mixture; a great deal tougher than a week ago."

"Fairly good coke."

"80 per cent of coke looks good for this mix but 20 per cent is soft large black lumps and somewhat crumbly."

Table VI—Extremes in Second Period Coal Mixture

<table>
<thead>
<tr>
<th>Daily Average</th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>5.76</td>
<td>2.01</td>
</tr>
<tr>
<td>Ash</td>
<td>7.70</td>
<td>6.48</td>
</tr>
<tr>
<td>Sulphur</td>
<td>9.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Through 1/4 in.</td>
<td>73.75</td>
<td>62.49</td>
</tr>
<tr>
<td>Coking time, hours</td>
<td>25.6</td>
<td>20.1</td>
</tr>
</tbody>
</table>

"Coke fair."

"Coke fair."

"Coke looked good in size and burn—but too much large slate causing cross fracture and breakup worse than otherwise; finer pulverization could help structure."

You can readily see that the lack of uniformity in the quality of the coal was immediately reflected in the quality of the coke (although we must admit that the ragged coke oven pushing schedule was not conducive to regular blast furnace coke; and irregular coke, irregular in structure and analysis, immediately gave unsatisfactory blast furnace operation, as shown in Table VII.

Third Period

During the third period the coal mixture at the coke ovens from Feb. 12th to Feb. 25th inclusive was 75 per cent West Virginia and 25 per cent Pocahontas. There was much improvement in the West Virginia coal and a drop in the ash in the Pocahontas coal; there were 94 cars of West Virginia coal coked in this period out of a total of 269.

Table VII—Extremes in Blast Furnace Results

<table>
<thead>
<tr>
<th>Daily average</th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tons pig</td>
<td>422.8</td>
<td>372.2</td>
</tr>
<tr>
<td>Coke per ton pig, pounds</td>
<td>1906</td>
<td>1639</td>
</tr>
<tr>
<td>Average silicon, per cent</td>
<td>1.19</td>
<td>0.78</td>
</tr>
<tr>
<td>Average sulphur, per cent</td>
<td>0.054</td>
<td>0.021</td>
</tr>
<tr>
<td>Actual yield of burden, per cent</td>
<td>59.54</td>
<td>54.76</td>
</tr>
<tr>
<td>Average blast temperature, deg</td>
<td>1150</td>
<td>1051</td>
</tr>
</tbody>
</table>

Although such extremes are to be avoided if possible, there was a better blast furnace operation during this last period than in the previous two periods and the furnace results for the last week of the test were quite satisfactory.

Table VIII—Extremes in Coal Mixture

<table>
<thead>
<tr>
<th>Daily average</th>
<th>Highest</th>
<th>Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4.62</td>
<td>2.95</td>
</tr>
<tr>
<td>Ash</td>
<td>7.62</td>
<td>5.54*</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.94</td>
<td>0.74</td>
</tr>
<tr>
<td>Through 1/4 in.</td>
<td>76.15</td>
<td>61.25*</td>
</tr>
<tr>
<td>Coking time, hours</td>
<td>27.0</td>
<td>23.0</td>
</tr>
</tbody>
</table>

*Last day. †First day.

The inspection reports at the blast furnace contained the following descriptive comments:

"Coke blocky, showing effect of low volatile coal; good for size and burn, but appears to be over-quenched as it is very wet and a lot of fine breeze adhering to lumps."

"Coke blocky—size good—too much slate showing in fracture of coke, hard burned."

"Poor quality today—too much large soft black coke—quite a bit shows raw coal—very wet."

"Coke good."

"Most coke very good—some too soft."

"Very blocky—appears to be best coke physically of any yet received."

"Good coke—about the same as yesterday."

Last Week of Blast Furnace Test

The last seven days that the West Virginia coal mixture coke was used in the blast furnace showed better and more uniform results than any part of the test (see Table X).

In his conclusions the coke oven superintendent said: "While we think the coke looks rotten, the furnace is proving that it is satisfactory. After all, the results obtained in the furnace operation is the final answer."
Table X—Blast Furnace—Final Week

<table>
<thead>
<tr>
<th>March</th>
<th>Tons of pig</th>
<th>Blast temperature, deg.</th>
<th>Blast pressure, lb.</th>
<th>Si %</th>
<th>S %</th>
<th>Coke per ton pig, lb.</th>
<th>Actual yield, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>428.2</td>
<td>1076</td>
<td>13.85</td>
<td>.97</td>
<td>.024</td>
<td>1659</td>
<td>58.66</td>
</tr>
<tr>
<td>2</td>
<td>418.3</td>
<td>1048</td>
<td>13.52</td>
<td>.92</td>
<td>.029</td>
<td>1698</td>
<td>55.33</td>
</tr>
<tr>
<td>3</td>
<td>419.5</td>
<td>1022</td>
<td>13.54</td>
<td>.91</td>
<td>.030</td>
<td>1635</td>
<td>56.36</td>
</tr>
<tr>
<td>4</td>
<td>425.0</td>
<td>1168</td>
<td>14.02</td>
<td>.66</td>
<td>.033</td>
<td>1680</td>
<td>55.35</td>
</tr>
<tr>
<td>5</td>
<td>406.8</td>
<td>1083</td>
<td>13.42</td>
<td>.98</td>
<td>.023</td>
<td>1634</td>
<td>56.03</td>
</tr>
<tr>
<td>6</td>
<td>435.1</td>
<td>1084</td>
<td>14.40</td>
<td>1.01</td>
<td>.019</td>
<td>1671</td>
<td>55.43</td>
</tr>
<tr>
<td>7</td>
<td>422.4</td>
<td>1079</td>
<td>14.29</td>
<td>.97</td>
<td>.020</td>
<td>1619</td>
<td>56.53</td>
</tr>
<tr>
<td>Average</td>
<td>422.2</td>
<td>1080</td>
<td>13.86</td>
<td>.92</td>
<td>.025</td>
<td>1656</td>
<td>56.24</td>
</tr>
</tbody>
</table>

Summary

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total West Virginia coal charged into ovens, tons</td>
<td>20,042</td>
</tr>
<tr>
<td>Total coke—furnace and domestic, tons</td>
<td>13,404</td>
</tr>
<tr>
<td>Approximate commercial yield per ton dry coal</td>
<td></td>
</tr>
<tr>
<td>Egg, per cent</td>
<td>10.39</td>
</tr>
<tr>
<td>Walnut, per cent</td>
<td>3.49</td>
</tr>
<tr>
<td>Total, per cent</td>
<td>69.12</td>
</tr>
<tr>
<td>Breeze, per cent</td>
<td>5.08</td>
</tr>
<tr>
<td>Total coke and breeze, per cent</td>
<td>74.20</td>
</tr>
</tbody>
</table>

The Pocahontas slack coal used in the mixture during this test analyzed as shown in Table XI.

The operating obstacles that were shown up in this coking test convinced the management of the companies interested that better cleaning of West Virginia coal was necessary and that furnace coke and foundry coke were two different products and must be handled in separate ovens and on separate coke wharves.

The coal company realized the possibility of needing some kind of cleaning plant for the smaller sizes of coal when the steel tipple was erected and provision was made for adding a washery or a dry cleaning plant later on if conditions warranted further cleaning of the coal. The coking test results brought about renewed interest in the cleaning of the minus four-inch coal. A washery was erected and put into operation last year, and all the coal except the lump is put through the Rheolaveur plant.

Last month I visited the mine for the first time in three years and found that the washed coal through 4 1/2-in. screen (egg coal is now 4 1/2 in.-2 in. instead of 4 in.-2 in. as in the coke test) was averaging lower in ash and sulphur than did the lump and egg coal that was hand-picked and sent to the coke ovens four years ago.

The moisture in the egg coal (4 1/2 in.-2 in.) is practically the same after washing as it was formerly. The moisture in the slack coal as shipped runs about 5 1/2 per cent, but it is about 4 1/2 per cent when it arrives at its destination in fair weather. In coal as in iron ores, it is often the case that high surface moisture is on account of the wet clay mixed with the coal or with the ore. When the clay is washed out the moisture carrier is thus removed, and we have the anomaly of washing with water to make it less wet. The Carpenter drier takes out all but about 2 per cent of the extraneous moisture in the slack coal.

The Rheolaveur washer takes out considerable sulphur from the slack coal because the fine pyrites are easily separated. The recovery of coal in this mine for the year 1930 was 89.3 per cent.

It looks as though Mr. Farrell's barrel of apples would be at least 90 per cent all good if they had been washed in the first place.

Table XI

<table>
<thead>
<tr>
<th>Period</th>
<th>Highest ash, %</th>
<th>Lowest ash, %</th>
<th>Average ash, %</th>
<th>Volatile, %</th>
<th>S %</th>
</tr>
</thead>
<tbody>
<tr>
<td>First period</td>
<td>8.20</td>
<td>5.28</td>
<td>6.67</td>
<td>18.68</td>
<td>.71</td>
</tr>
<tr>
<td>Second period</td>
<td>8.86</td>
<td>4.70</td>
<td>7.06</td>
<td>17.72</td>
<td>.68</td>
</tr>
<tr>
<td>Third period</td>
<td>8.96</td>
<td>4.86</td>
<td>6.05</td>
<td>17.36</td>
<td>.68</td>
</tr>
</tbody>
</table>

A. C. Dinkey Dies

A. C. Dinkey, president, Midvale Company, Philadelphia, died of heart failure at Wynewood, Pa., August 11. He had been in a weakened condition since illness of pneumonia three months ago. Mr. Dinkey was a director of Midvale, the Baldwin Locomotive Works and the American Iron and Steel Institute.
The Lubrication of Roll Necks with Oil

The author claims success for an interesting method of oil-lubrication

By H. A. SLATTENGREN

The all-bronze bearings with or without oil grooves (which really did not mean much anyhow), lubricated from the sides with heavy black grease, are fast becoming things of the past. In the majority of cases, the lubrication of the roll neck is not only inadequate, but quite dangerously in the proximity of nil. To compensate for this lack of lubrication, a stream of water is played upon the roll neck to prevent the groaning bearing from bursting into a relief of smoke and flame.

Luckily, those days are in the twilight, because the era of mechanical lubrication has dawned. However, the position of the roll necks in a vertical line suggests a very simple and cheap, but altogether effective means of lubrication. The idea first occurred while a set of three-high herringbone mill pinions were being overhauled and relined. The journals ran in babbitt lined bearings with the customary criss-cross oil grooves, which were supposed to distribute the oil throughout the bearing, and would have done so if the oil had ever reached the grooves. The lower teeth of the bottom pinion dipped for several inches into a heavy black oil of excellent lubricating qualities, and this was carried up to the teeth of all the pinions so that they were very well lubricated indeed. Some of this oil was supposed to reach and lubricate the bearings, but entirely too little of it did, because the pinions rotated about 95 r.p.m. and threw off the excess oil as spray against the side and top of the case. Furthermore, the teeth were half-shrouded.

An idea was carried out that has ever since proved entirely effective and satisfactory. Most of the bearing halves had to be rebabbitted, and the others were near the ragged edge. This gave us a splendid chance to try the scheme, which was as follows: A trough formed of sheet steel was attached inside the lid directly above the top pinion in such a manner as to catch the oil spray thrown off, and lead it to the bearings at each end of the pinion. The

Diagram of method for the oil-lubrication of roll necks
collars of these bearings were provided with slots having ample angles of approach. These slots communicated with oil grooves that led to the sides of the bearing. This is shown better than can be described on the accompanying illustration of a bearing for roll necks.

The captured oil spray flows down the gutter and into the slot directly onto the top of the journal. From there it is distributed over the bearing and the excess is led by the oil grooves to overflow the sides and into the oil grooves of the lower bearing which has oil grooves and a slot identical to the upper one. The excess oil follows the oil grooves and finally reaches the slot in the bottom bearing and from here drops directly into the slot in the bearing underneath. The cycle is again repeated until the excess, if any, drops into the oil pit. The success of this scheme for mill pinions has to date been unqualified.

This method can be applied equally well for the lubrication of roll necks. In this case the oil must be supplied to the slot through suitable piping from a tank (preferably overhead). The oil in the tank should be under air pressure, governed by an adjustable pressure regulator. The oil slots and grooves should be amply wide, and there is no particular advantage in using a too heavy oil. The viscosity of the oil is certainly less apparent when it reaches the thickness of a film in the bearing.

Water should not be used on the roll neck bearings. More water should be used on the body of the roll if necessary to cool off the bearings. It is better to use more oil on the bearings for a while until things cool off a little—water and oil do not mix, and the water ruptures the oil film and washes it away. Comparatively little oil is required if it reaches the right place at the right time, and does so continuously. Oil, in our experience, has been found to be the most effective of all forms of lubricants.

The advantages of the cascade method of roll neck lubrication are: The lubrication is visual, continuous and automatic without any mechanical aid. No pumps, fittings or piping to the bearings are required. These items are very often troublesome because of breakages, crushing and clogging. In case of a tendency to overheat because of excessive loads or extremely hot weather, all of the bearings can be quickly flooded with oil and thereby cooled.

Efficiency Court for Accident Prevention

(Continued from page 1234)

The accident was owing to inefficient supervision.

The jury returned the following verdict: We, the jury, find the accident entirely owing to the use of inadequate and inefficient equipment.

The following day we received three suggestions out of which was devised a tool that performs the same work with one man in fifteen minutes. It saves thirty minutes’ time and relieves two men for other work with all accident danger eliminated.

Thus we have a comparative result between efficient thinking and safe thinking.

We have been using the efficiency court for several months and while we have far to go before we reach the goal we have set, the change in attitude of the organization, the progress in clear thinking, planning, accident reduction, quality and quantity of work produced, all tend to convince us that accident prevention is a matter of efficient organization, efficient operation and efficient thinking.

New Plate Mill for Tennessee Coal, Iron & Railroad Company

MACHINERY for the new universal plate mill of the Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., is being delivered by the manufacturer, the Hardie-Tynes Company, Birmingham. It was designed by Mackintosh-Hemphill Company, Pittsburgh.

About 40 railroad cars were required to deliver the equipment as shown partially assembled at the plant of the manufacturer. The machinery is 100 ft. wide and 150 ft. long and weighs about 2,000,000 lb. It includes the cooling bed, transfer, running table, runout table, straightener, plate inspection, tilter and shear delivery table. Power is furnished by 17 electric motors of 50 to 100 hp. More than a year was required in its construction.

The universal plate mill at the Fairfield plant as well as the new sheet mill and open hearth furnace are part of the improvement program authorized by the U. S. Steel Corporation early in 1930 when an $8,000,000 appropriation was made for that purpose.
The use of the oxygen lance in open hearth steel plants has become a regular production operation. One large steel company has recently installed a complete new oxygen distribution system to facilitate lance cutting operations in various parts of its plant. A new manifold house has been constructed adjacent to the plant and a 30-cylinder wall type oxygen manifold has been installed. An oxygen pipe line brings the oxygen supply from the manifold house to the plant and an oxygen header runs the whole length of the plant near the rafters over the line of furnaces to provide oxygen for the tapping of the furnaces. Drop lines come down from the header to each of the 12 furnaces, the lance being located on a platform near the furnaces.

The oxygen lance is the most economical method of tapping open hearth furnaces and the procedure for its use is quite simple. One workman handles the lance while a second one adjusts the pressure from a regulator on the drop line. The end of the lance is first put into the furnace and held there...
until it becomes red hot. Then the oxygen is turned on gradually, and the end of the lance is placed against the plug in the tap hole. The oxygen pressure is increased as the workman moves the lance in and out and cuts a hole of the correct diameter. Usually about one minute after the start of this operation the plug has been pierced and the appearance of smoke shows that the metal is being burned. A few seconds after the smoke appears, the steel flows from the furnace down the steel runner into the waiting ladle. The tapping of furnaces with the oxygen lance leaves the furnace tap hole in much better condition than when it is opened by the older methods.

Fig. 1 shows the tapping with the oxygen lance of one of the furnaces in the steel plant referred to above. After the molten metal has filled the ladle and the slag has been run off into the slag ladle, shown to the right in Fig. 1, the large ladle is picked up by a traveling crane and the metal is poured into ingot molds which are lined up on small flat cars. In pouring the ingots, the stopper at the bottom of the ladle occasionally becomes frozen and will not open, so that it is necessary to use the oxygen lance on the nozzle. The operator stands on the cooling platform to one side and only a few seconds are required to bring a full flow of metal.

This steel company recently received an order which involved the casting of 120 ingots of high nickel steel. Special steels such as this nickel steel are cast in hot top ingots. A pool of molten metal is maintained at the top to fill the shrinkage cavity forming below as the main mass of steel solidifies. For this procedure the top end of the ingot mold is built up with a mixture of ground brick and coke high enough to take care of this pipe well. By using this method they were able to produce an ingot giving them the required amount of finished stock. The ingot is allowed to cool in the mold for a period of three hours after pouring, and when the mold is removed it is necessary to remove the hot top as quickly as possible so that the ingot does not become chilled and consequently check owing to its high nickel content. The ingot must also be taken to the soaking pit for reheating preparatory to rolling into plate before it cools. The section of metal to be removed from the top end of the ingot, known as the 'hot top," was about 24 in. thick by 66 in. in width. The oxygen lance was naturally the logical means to employ to remove this section from the hot ingot, and under the advice of a service operator of the oxygen manufacturer, the plant operators were able, by using two lances properly handled, to cut off a "hot top" in about 15 min. with a minimum consumption of oxygen. Fig. 2 shows the two plant operators removing the "hot top" of a nickel steel ingot. It will be noted that a cover was placed over the hot ingot to protect the operators from the heat which was about 1500 deg. F., when the lance operation started. The second lance was used to carry off the slag from the bottom of the cut and in this way speeded the cutting considerably and actually lessened the oxygen consumption. The smoothness of the completed cut may be seen in Fig. 3.

The above mentioned uses of the oxygen lance are only two of the more common applications of the lance in the modern open hearth steel plant. There are innumerable other ways in which the oxygen lance and the oxy-acetylene process are used to good advantage in nearly all steel plants. Another very common use of the lance is in the reclamation of furnace spills, frozen ladles and salamanders. Lances and cutting blowpipes working together have removed spills which have accumulated under old furnaces over periods as long as 25 years. At times several thousand tons of stratified steel lying in dirt have been removed and reclaimed at a cost of less than half the value of the material. The oxygen lance has made it possible to return to the furnace many thousands of tons of materials that would otherwise be valueless and would needlessly occupy space about the plant.

Automatic Reversal from Temperature-Difference

TODAY it is generally recognized that reversal of a regenerative furnace on an empirical time-cycle basis is fundamentally wrong. Its general use in the past has only been tolerated because of the lack of a more efficient system. Reversal should properly depend upon the conditions of the heat and the actual temperatures occurring within the furnace.

Regenerative furnace operation in general has been studied by Leeds & Northrup engineers for the past seven years. A concentrated research into open-hearth operation specifically was begun in 1928, to determine the conditions normally encountered in actual operation as an open-hearth furnace (Continued on page 1243).
In the early days "soda water" and "soap water" were used for light machine work, and "lard oil" for heavy work. I remember distinctly when the war came on and the price of lard oil rose to such a height to make it anything but economical for factory use and someone conceived the idea of manufacturing a sulphur cutting oil. The "old timers" all declared it couldn't be done. At the present time probably not 1 per cent of the manufacturing shops throughout the country use straight lard oil. I well remember the first time an enterprising salesman attempted to sell a water soluble for pipe threading to the shop in which I happened to be working at that time. Our superintendent had just passed through the change from lard oil to sulphur oil, and while the shop as a whole took the stand water solubles couldn't be used for pipe threading, our superintendent insisted that it be given a trial and finally took an arbitrary stand that we must use it. Having no other alternative everyone set about to give full cooperation and within a short while it would have been practically impossible to put an oil back in the shop.

The "soda water" of the early days acted merely as a coolant until someone conceived the idea of adding a light paraffine oil and giving it a lubricating quality as well.

Later the idea was further developed by the addition of higher grade mineral oils, creating a relatively superior compound, and this process has been followed out step by step until in some of the present day compounds we find lubricants such as lard oil and castor oil, combined of course with water, the original and, shall we say, ideal coolant.

True Value of Solubles

Probably the greatest hindrance to the education of machine shops in the real value of water solubles is the fact that so many manufacturers of solubles themselves fail to realize their true value. For instance, there are almost hundreds of concerns today who manufacture soluble oils—a combination of soap and light paraffine oil which is practically identical with the first soluble oil put on the market. There are many manufacturers of solubles who do not go very far into research work to enable them to analyze the jobs with which they come in contact so that they can with any degree of certainty recommend a compound with the suitable grade of lubrication to successfully handle the job. Naturally, a man having only a straight soluble oil will try to sell it for any job on which he sees the water soluble in operation, not realizing that the soluble then on that particular job contains many times the lubricating value of the ordinary soluble oil. Quite naturally, too, when the shop man has tried a number of such soluble oils without success he comes to the point where all solubles are "soluble oil" to him, and when he is offered a soluble compound containing sufficient lubricating value to handle the job entirely satisfactorily he very often refuses to run any more tests—simply a case where a burned child dreads fire.

The early grinding solution was simply water with soda added as a softener and rust preventative. Later soluble oils were used quite extensively in grinding until the more enterprising of the present day have come to realize that there are essential requirements in a grinding compound, namely: As a coolant; as a lubricant for the thousands of miniature cutting tools on the face of the wheel; as a cleaner of the wheel so that it does not become a buffer instead of a cutter; as an anti-rust element, and probably most important, as an element to precipitate chips so that they do not continue to float in the solution and mar the finish where a very high finish is required.

The cutting lubricants range with a lubricating content anywhere from light paraffin oil up to the highest grade vegetable and animal fats with corresponding values.

It has been definitely proven that the most difficult drawing of rounds, shapes, steel tubing, etc., can be done just as efficiently and far more economically with compounds as with mineral oils since the better grade of lubricants has been incorporated into the compounds.

In grinding, cutting and drawing operations the cooling quality of the water in the solution plays a great part, but in deep drawing operations the water content is so low that its value as a coolant is practically negligible, and it is in these deep drawing operations that the compounds are put to the most severe test possible, at least in my opinion. Most certainly the lubricating value is brought out in the first minute of the operation and it is here.
that the superior quality of the better grades of lubricants are proven, while on a cutting operation it will probably take days, or at least hours, to determine the difference and results derived.

The most common questions raised in connection with water solubles are "Will it rust?", "Will it go rancid?", and "How much does it cost?". Answering the first question: Any compound will rust if the mix is carried to extremes. There is naturally a limit to any anti-rust element. When products are machined with solubles there is a film left which acts as a rust preventative as long as the material is stored inside and under reasonable atmospheric conditions. If these materials are placed outside in the rain, this film, being soluble in ordinary system water, is more soluble in soft rain water and naturally washes off very quickly, with rust as a result. I have seen materials which were machined in solubles and stored inside lay for months without any indications of rust whatsoever.

**Rancidity**

As to rancidity: Any water soluble will go rancid in time if not treated in a sensible manner. Most compounds are slightly alkaline, but if foreign substances such as banana peels, orange skins, parts of sandwiches, etc., are thrown into them these substances decay and set up an acid condition with rancidity as a result. In fact, pure distilled oil if allowed to set open under certain conditions will become rancid. A simple remedy for guarding against rancidity in any solubles is to add a small amount of sal soda, soda ash or tri-sodium phosphate every two or three days to counteract the acid caused by foreign substances which invariably find their way into the systems. Solutions which have gone rancid have been brought back to their original alkaline condition by this means.

Costs of compounds naturally vary with the grade of oil used in their manufacture, but the cost of the solution mixed ready for the machine will run possibly 5 to 10 per cent of the cost of an ordinary sulphur cutting oil. Recently a certain shop superintendent was using a soluble solution which cost five cents per day per machine. His business was solicited on a higher grade soluble which would have doubled his cost and naturally he raised quite an objection. Nevertheless when questioned as to the value of the milling cutter in use on the machine he admitted that it cost $175.00. Up to that time his mind had been centered on reducing the cost of his cutting solution to the neglect of the cost of his cutting tools, or rather to the ultimate cost of production which was governed by the combined cost of his lubrication and cutting tools. When this was pointed out the man raised no further objection to a trial of the higher priced and higher grade compound and found an additional tool wear of 30 per cent, which meant that his tools and lubrication combined cost him much less than his tools alone had previously cost, even though the cost of the lubrication itself had been doubled.

The most important points in the use of water solubles are: Analysis of the job to be done so that the proper grade of soluble is applied to the job, and that it be applied in the correct manner. It is almost universally necessary that a good-sized stream of solution be applied directly on the job for the reason that the solution being thin does not cling to the work as oil does. For instance, in threading large pipe, only one stream of oil will work satisfactorily because the oil clings to the pipe in its complete revolution.

If only one stream of compound is applied ample lubrication is furnished on the down-turn and no lubrication at all is received on the up-turn. Consequently it is necessary to put two or more streams on so that all tools are properly lubricated. Very often oil will be working satisfactorily in a machine and when compound is put in the machine with the same tool on the same grade of work satisfactory results will not be obtained immediately for the reason that in addition to lubricating the point of the cutting tool an oil clings to the throat and helps the chip to clear itself, whereas the compound, being thin, does not hang on to the tool and give the same aid in clearing. On the contrary, if a tool is working satisfactorily on a water solution and the machine is changed over to oil on the same set-up, satisfactory results are still obtained. In other words, the job is very often done satisfactorily with oil despite the lack of clearance in the cutting tool rather than because of the lack of clearance. It then becomes necessary when using water solutions to allow all clearance possible, of course being careful to not reach the "chattering" stage.

It is safe to say, during the last few months of business depression, when conservation was the watch word, that more development has taken place in the use of water solubles and the manufacturers have learned to appreciate the difference in the variation of the different grades of solubles more than in the few preceding years, and there is very little doubt but this attention and development will continue until manufacturers as a whole reach the point where water solubles will almost entirely replace oils for all ordinary machining processes and cold-drawn operations.

**Automatic Reversal from Temperature Difference**

(Continued from page 1241)
Inasmuch as the various processes necessary to the manufacture of steel are today conducted with a precision and an efficiency never before known, this article describes in detail the means for carrying out one of the processes—the generation of steam—employed at the plant of a large and progressive steel company.

By CHARLES LONGENECKER

POWER generation in our steel plants is today receiving the attention it deserves. Many steelmakers remember that twenty years ago steam, although necessary to plant operation received consideration only as a medium for keeping an engine in motion. The equipment for generating it was usually of far lesser importance to plant officials than was the equipment for making steel.

One has but to inspect the new boiler house at the Campbell plant of the Youngstown Sheet & Tube Company to appreciate the importance attached to steam generation by the officials of this company. This boiler house in design and operation compares favorably with the best central station practice, considering of course the limitations imposed upon it by the varying conditions of load and fuel supply.

Steam from the new boilers was first delivered to the power creating units in December, 1928. It is generated in six Babcock & Wilcox Stirling type boilers, each with a heating surface of 20,283 sq. ft. and a width of 60 tubes.

The principal fuel is blast furnace gas, and the auxiliary fuel powdered coal. Gas is furnished to the boilers from four blast furnaces which have a maximum capacity of approximately 280,000,000 cu. ft. of gas a day. The gas is carried to each end of the boiler house through two 7-ft. mains from which delivery is made to a 7-ft. ring boiler (individual furnace) main. At each end of the boiler house, where two of the 7-ft. mains enter, are water seals and automatically controlled butterfly valves. The valves are regulated by steam pressure according to the steam demand. A minimum gas pressure control operates to close the butterfly valves in case of a blast furnace gas main pressure below four ounces.

Before delivery to the boiler burners the gas is cleaned to a dust content maximum of .25 grains a cu. ft. by three McKee five-stage wet gas washers. Coal is obtained from several mines, hence the analysis varies. It is received in hopper cars in the form of slack.

A large hopper extending beneath two tracks receives the coal when it falls from the cars. The coal drops from this hopper onto a Beaumont automatic skip hoist which elevates it to a coal crusher at the

Burners at south side of boilers, Campbell power house
Exterior view of power house at Campbell showing gas pipes from blast furnaces.

Coal is delivered through steel chutes to two 15-ton Raymond pulverizers. These pulverizers are supplied with heated air from the main air preheaters in order that the coal can be dried. A 200-hp. General Electric motor drives each pulverizer. Coal at a fineness of approximately 80 per cent through a 200-mesh screen is exhausted by a fan from each pulverizer and, passing through the fan, is forced in a current of air into a collector where the coal is separated from the air and is deposited in either of two sets of spiral screw conveyors. One pair of conveyors extend along each side of the building and above the hoppers from which the coal is fed to the burners. In the section of the boiler house containing the coal pulverizers, sufficient space is provided for the installation of two more pulverizers.

Water Supply

The boilers are fed with condensate from all high pressure steam consuming units and with 2½ per cent to 7 per cent make-up supplied by pump turbines which use 150-lb. steam received from the low pressure system. The “makeup” is condensed exhaust steam and is, therefore, distilled water. Water is stored in two 100,000-gallon tanks.

In the basement of the boiler house are two De Laval emergency feed steam turbine driven centrifugal pumps with a capacity of 100,000 gallons a minute each at 1,100-ft. head. These units pump distilled water from the two 100,000-gallon make-up tanks when an emergency arises. All main feed pumps are electrically driven and are located near the units which consume the 400 lb. steam, and hence they carry away the condensate from these units. A make-up pump in the power house takes water from the make-up tanks.
The flow of feed water usually at a temperature of 360 deg. F., is controlled by “Copes” type regulators equipped with a constant differential valve in the same body as the main feed valve. There are two regulators to each boiler.

Water from the Mahoning river is used for condensing purposes and for the evaporators generating steam at 150 lb. pressure.

**Boiler House**

The building is 150 ft. long, 105 ft. wide and 105 ft. high. It is built of structural steel frame and covered with double corrugated copperoid steel sheets with insulation between, a design developed by The Youngstown Sheet & Tube Company. This type of wall is a better heat insulator than a 9-in. brick wall. The floors are of reinforced concrete.

The six boilers are arranged in two rows, with three boilers in each row. They are supported by loops suspended from cantilever beams framed into the boiler house steel work. Each boiler is provided with a 10-ft. diameter stack.

Gas flows into each boiler through three Steinbart burners, and coal through four Couch turbulent type burners. The gas burners are constructed of welded steel plate. Their operation is controlled by a Hagan oil driven motor unit. Coal is supplied to the four burners by double control feeders of the rotary gate type with positive feed at two speeds. These feeders are automatically controlled by steam pressure through Hagan control in combination with gas supply control. The coal and gas burners are placed in opposite walls, but with the gas burners 8 ft. above the center lines of the coal burners.

The furnace walls, which are air cooled, are of the American Arch Company type provided with air intakes so located that air can be admitted from either the basement or at the firing floor level as may be desired to meet summer or winter ventilating conditions. The furnace volume is 21,000 cu. ft. which gives a ratio of furnace volume to heating surfaces of 1 cu. ft. to 1 sq. ft. Inside furnace dimensions are: width, 30 ft.; depth at mud drums, 27 ft.; the height from the floor to the center of top drum is 43 ft. The furnace brick work is steel cased and is lined with asbestos insulation. Fine ash, or dirt, falls into a brick-lined air-cooled hopper equipped with Allen-Sherman-Hoff ash gates and from this it is carried into a hydraulic sluice system. The sluices extend to all drips and drains under the

 Crushed coal feeders on boilers in Campbell power house

Ash hoppers on coal feed side of boilers in power house at Campbell
Blower fans on top floor of power house at Campbell

gas main system. Ashes are collected in a large settling pit from which they are removed by a locomotive crane; the water is recirculated by means of a Cameron pump driven by a 5-hp. Reliance motor.

From the furnace the hot gases pass through three passes formed of interlocking tile. Soot is removed by Diamond soot blowers. A superheater, furnished by the Babcock & Wilcox Company and placed between the first and second passes, heats the steam to approximately 700 deg. F. The boiler tubes are 3/4 in. in diameter.

After the gases have passed through the boiler they are drawn by a 108-in. Sturtevant fan with a capacity of 184,000 cu. ft. a minute at a pressure of 8.4 in. of water into and through a Combustion Engineering Corporation plate type air heater with a heating surface of 20,100 sq. ft. Each air heater is equipped with soot blowers. Passing through the fan, the gases are exhausted to a stub stack at a temperature of from 450 to 550 deg. F. The top of the stack is 98 ft. 2 1/4 in. above the center line of the gas burner. A 450-hp. General Electric motor drives the induced draft fan. The speed of this fan and the movement of the damper is regulated by a Hagan control unit.

Air Supply

Combustion air is forced to each furnace by a Sturtevant fan, which has a capacity of 51,000 cu. ft. of air a minute at a pressure at maximum rating of 13 in. of water. This air is drawn through the furnace walls in which its temperature is raised; it is then forced through the air preheaters and to the burners where its temperature will approximate from 450 to 500 deg. F. The speed of the fans, which is manually controlled, varies from 350 to 680 r.p.m.

Boiler Operation

In the design of this plant it was the intention to burn gas as the principal fuel; however, should the gas supply at any time be insufficient, the load can be carried by the use of powdered coal. All the blast furnace gas not required by the stoves is turned into the boiler house mains. The units to be supplied with high pressure steam are: three 60,000 cu. ft. a minute turbine-driven blast furnace blowers, two 20,000 kw. turbo-generators, and six evaporators. Steam is generated at a nominal pressure of 400 lb. and at a temperature of 700 deg. F. The average boiler efficiency is approximately 75 per cent.

Especially interesting in the operation of these six boilers is the regulation afforded by the Hagan control system. The gas and the coal controls are so connected that gas is burned in preference to coal. The control is made responsive to variations in the steam pressure and when the pressure falls to a predetermined limit coal is supplied the burners in sufficient amount to restore the steam pressure. The full range of either fuel is available when required. Should the occasion arise, the entire boiler house control, which is normally automatic, can be operated by hand.

The draft control is made to function by variations in the furnace pressure at the gas burners. Each induced draft fan can be made to rotate at six different speeds; however, should closer draft regulation be desired, it can be obtained by a change in the position of the boiler damper which is controlled by a limit switch. By these means the severe conditions when burning coal or gas are met without hunting. Should the demand of the boiler for gas be not enough to take all the surplus from a blast furnace, a control opens on the blast furnace a 36-in. gas bleeder.

Steam Piping

Steam flows from the boilers in ring headers of seamless steel tubing fitted with loop expansion bends. The superheated steam headers are covered (Continued on page 1252)
Distributing Steam Costs in the Plant

Consideration of the amounts of various fuels and the means of calculating them

By L. G. JONES

PART VII

In addition to the actual steam distribution figures, there are several other reports that must be made up monthly by the plant steam engineer simultaneously with the departmental consumptions. While not directly related to the steam distribution, they are essential to the cost department in deriving their actual steam costs, which in turn find their way to the various departments via the steam distribution report.

These accessory reports also serve to summarize the monthly operations of the boiler plants and steam system, in their economy, load factor, efficiency, etc. They disclose these facts to the head of the steam department as well as to plant officials for comparison with previous results. Such information also enables the management to note the trend of conditions and expected results.

While some of this information may be valueless to the cost department for accounting purposes, it forms the basis for analysis of supervision and for interpretation of operations on items that are more or less intangible, unlike so many weighed tons of metal, pounds of supplies, hours of labor, etc. Some of these intangibles are blast furnace gas surplus, steam generation, water pumped, horsepower developed, and so on.

These reports become routine and are identical in form each month, so that immediate inspection and comparison with other periods becomes possible. Every industrial plant makes up similar reports in forms that best suit its particular needs, conforming to practically the same type of data that have become standardized to a great extent.

It is the purpose here to take up these accessory reports in general as related to the steam department of a steel mill, with the derivation of the various items.

Fuel Consumption of Boilers

The first of these reports contains a summarized statement of the consumption of the various fuels used in steam generation ultimately converted in equivalent net tons of coal.

Every steel mill has a number of types of fuel available, most of which are used in the boiler plant; especially the surpluses of certain classes of by-product fuels too valuable to waste. These must be consumed as produced since storage facilities for large quantities of blast furnace and coke oven gas may be out of the question. Purchased fuels are only used as needed to make up any deficiency for the production of the steam required by the plant. Many plants even utilize the waste heat from the open hearth and other furnaces for steam generation.

The boilers, operating continuously, form an ideal

Herman A. Brassert, Blast Furnace Practice
Cubic feet blast furnace gas produced per ton of iron for various coke rates
outlet for the consumption of waste heat-containing products, all of which are adaptable to boiler use. Hence the gross fuel consumption may be a fairly complicated item of derivation.

In the plant under discussion the fuels available for boiler firing are:

1. Blast furnace gas.
2. Coke oven gas.
3. Coke breeze.
4. Slack coal for stoker use.
5. Selected coals for hand firing.
6. Tar and oil.

Of these the first three fuels are given preference due to the fact that they are produced in the plant and may have no other outlet. Tar, also a plant by-product, as well as fuel oil, is considered extremely valuable for open hearth furnace heating, especially in conjunction with coke oven gas. Adequate stor-

age tank capacity permits the accumulation of these liquid fuels during week-ends and non-productive periods so that they are not used for boiler firing.

Fuel oil and coal are externally obtained fuels, usually purchased, and their usage involves extraneous costs to the plant, so that their use is avoided until all by-product fuels and heat wastes are recovered.

**Blast Furnace Gas**

The first fuel to be considered is blast furnace gas, of which a large portion in its raw state is available at all times for boiler use. A considerable percentage of the total volume generated by the blast furnaces in the reactions of the air with the coke and other materials comprising the burden is utilized in heating the stoves that preheat the air blast to the furnaces. The amount of gas yielded has been reduced to empirical formulas by Brassert and depends upon the coke rate or ratio of weights of coke per ton of iron produced, upon the wind blown, and on the furnace practice—its production, temperatures, etc.

![Blast furnace gas heat value and analysis.](image)

Blunt furnace gas heat value and analysis. Their variation for different coke rates

From these formulas, including the evaluation of local furnace practice, the blast furnace gas supplied to the boilers can be calculated. The resultant fuel values are derived as equivalent tons of coal and the boilers are charged with this tonnage at current plant coal prices. The blast furnaces are credited with this heat recovery.

The method used is based upon Brassert’s equations applied to actual plant operating conditions, as follows:

Heat value of blast furnace gas = 0.94 \[70.5 + (0.016 \times R)\] where R = coke rate, in lb. dry coke per ton iron produced.

Heat available for boiler use per gross ton of iron produced = 0.95 × R \[
\left(1.02 \times R + \frac{4495 - \frac{17 \times \text{ca. ft. free air blown}}{\text{stove efficiency}}}{100}\right)
\]

Total heat received by boilers = 0.95 × heat available × gross tons of iron produced during the period.

Coal equivalent of blast furnace gas used by boilers, in net tons of coal =

\[
\text{Total heat received by boilers} = 13,500 \text{ B.t.u. per lb. coal} \times 2000 \text{ lb. per ton.}
\]

One of the regular monthly reports utilizes these formulas in determining the blast furnace gas used in the boilers during the completed month. This recovered heat in terms of equivalent coal is charged to the boiler plant and at the same time credited to the operations of the blast furnaces that have pro-

*Year Book, Iron and Steel Institute, 1914.*
duced the gas. This report, which comprises two of the blast furnaces, is shown in Table I.

To serve as a check on these calculations and on the data recorded, as well as to possibly give an empirical operating ratio between the coke charged into the blast furnace and the steam recovered from the by-product gas, a figure can be derived from this series. This unit factor gives the evaporation in pounds of water per pound of coal. It varies each month, but averages about 9.1 lb. water for the blast furnace boiler house.

In this plant considerable coke oven gas is available for boiler use, especially during the week-ends when the mill furnaces are idle. The surplus coke oven gas delivered from the coke plant to the steel mill is metered at the booster station of the by-product department of the coke plant from which point it is sent to the steel mill. At the mill the gas utilized by the open hearth department and the various mills is metered at the inlets to each of these departments. The unconsumed steel mill surplus in whatever quantities that are left unused, is conducted to the boilers unmetered, so that no direct measurement of the actual boiler consumption is possible. The derivation of this quantity can only be made by the difference between the coke plant send-out and the totalized usage of all other departments.

Before the departmental gas meters were installed this gas consumption could only be determined from the boiler steam output and the deficiency in the required fuel input necessary to generate this steam. This figure was first determined as the coal equivalent and recalculated subsequently as gas. The method in general was as follows:

\[
\text{Fuel input in tons of coal for No. 3 boiler house} = \frac{\text{Total steam output from and at 212 deg. F.}}{970.4 \text{ B.t.u. per lb. steam}} \times 13,500 \text{ B.t.u. per lb. coal} \times 2000 \text{ lb. coal per ton}
\]

Gas consumption as equivalent coal—This is equal to the difference between the above calculated total fuel input required to produce the given output of steam, and the actual known fuels used; the latter fuels are only coal and coke breeze.

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**Table I—Blast Furnace Gas Consumed by Boilers. Month of July, 1930.**

<table>
<thead>
<tr>
<th>No. 1 Blast Furnace</th>
<th>Air blown to furnace</th>
<th>1,862,312 M-cu. ft. for month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke consumed</td>
<td>33,879,856 lbs. as charged, 2.5 per cent moisture</td>
<td></td>
</tr>
<tr>
<td>Coke consumed</td>
<td>33,022,600 lbs. dry</td>
<td></td>
</tr>
<tr>
<td>Iron produced</td>
<td>17,725 gross tons</td>
<td></td>
</tr>
<tr>
<td>Dry coke per ton iron</td>
<td>1,984 lb.</td>
<td></td>
</tr>
<tr>
<td>Cubic foot air per pound coke</td>
<td>55 cu. ft.</td>
<td></td>
</tr>
<tr>
<td>Efficiency of stoves</td>
<td>55 per cent</td>
<td></td>
</tr>
<tr>
<td>Heat value of gas:</td>
<td>0.94 [70.5 + (0.016 \times 1.863)] = 94.3 B.t.u. per cu. ft.</td>
<td></td>
</tr>
<tr>
<td>Heat available for boiler use per gross ton of iron produced:</td>
<td>0.95 (1863) [(1.03 \times 1863) + (4.495 - 17 \times 55/0.55)] = 8,343,800 B.t.u.</td>
<td></td>
</tr>
<tr>
<td>Heat received by boilers during month:</td>
<td>0.95 \times 8,343,800 \times 17.725 = 140,463,000,000 B.t.u.</td>
<td></td>
</tr>
<tr>
<td>Coal equivalent of blast furnace gas used by boilers:</td>
<td>1/46,000,000,000 \times (13,500 \times 2000) = 5,202 net tons.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. 2 Blast Furnace</th>
<th>Air blown to furnace</th>
<th>1,887,920 M-cu. ft. for month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke consumed</td>
<td>34,507,370 lb. as charged, 2.5 per cent moisture</td>
<td></td>
</tr>
<tr>
<td>Coke consumed</td>
<td>33,644,686 lb. dry</td>
<td></td>
</tr>
<tr>
<td>Iron produced</td>
<td>16,955 gross tons</td>
<td></td>
</tr>
<tr>
<td>Dry coke per ton iron</td>
<td>1,984 lb.</td>
<td></td>
</tr>
<tr>
<td>Cubic foot air per pound coke</td>
<td>54.6 cu. ft.</td>
<td></td>
</tr>
<tr>
<td>Efficiency of stoves</td>
<td>50 per cent</td>
<td></td>
</tr>
<tr>
<td>Heat value of gas:</td>
<td>0.94 [70.5 + (0.016 \times 1984)] = 96.2 B.t.u. per cu. ft.</td>
<td></td>
</tr>
<tr>
<td>Heat available for boiler use per gross ton of iron produced:</td>
<td>0.95 (1984) [(1.02 \times 1984) + (4.495 - 17 \times 54.6/0.50)] = 8,753,000 B.t.u.</td>
<td></td>
</tr>
<tr>
<td>Heat received by boilers during month:</td>
<td>0.95 \times 8,753,000 \times 16,955 = 140,987,000,000 B.t.u.</td>
<td></td>
</tr>
<tr>
<td>Coal equivalent of blast furnace gas used by boilers:</td>
<td>140,987,000,000 \times (13,500 \times 2000) = 5,218 net tons.</td>
<td></td>
</tr>
</tbody>
</table>
Gas fuel as equivalent coal = Total fuel input — known balance of fuels.

Assuming the boiler efficiency to be same for gas as with solid fuels properly fired with good stokers, the gas consumption equivalent to the coal difference obtained above is obtained by direct conversion of corresponding heat values, thus:

\[
\text{Gas} = \frac{\text{equiv. coal} \times 13,500 \text{ B.t.u.} \times 2,000 \text{ lb.}}{560 \text{ B.t.u. per cu. ft. gas}} \times \frac{\text{cu. ft.}}{\text{cu. ft. of gas}}
\]

One ton coal = 48,500 cu. ft. gas.

The actual calculation for one month showed the following results:

Fuel input in tons of coal:
137,182,000 lb. steam × 970.4 B.t.u. = 7,160 tons. 69% eff. × 13,500 B.t.u. × 2,000 lb.

This boiler house, in addition to its use of coke oven gas and coal, had a boiler operating solely upon coke breeze in a chain stoker. This coke breeze, in a special boiler coal distribution report, was converted into equivalent coal, as will be discussed later. Hence, the known coal weights were a composite of the actual coal plus the coke breeze recalculated as its equivalent coal:

Coke oven gas in terms of equivalent coal:
7,160 — (5330 + 770) = 1,060 net tons of coal equivalent.

Coke oven gas consumed during month:
1,060 \times 13,500 \text{ B.t.u.} \times 2,000 \text{ lb.}
560 \text{ B.t.u. per cu. ft. of gas} = 51,300,000 \text{ cu. ft.}

This figure then became one of the known values of the distribution report on coke oven gas, also made up each month, and which may be discussed later. This report, with the usage of the various departments actually metered, becomes simply a tabulation of the monthly totals to each department. Costs are based upon total metered cubage at a definite rate per 1000 cu. ft. as established. Percentages are not used.

Coke Breeze

Mention was made of the use of coke breeze in certain boilers at two boiler houses. Owing to the constant supply of this by-product fuel, the various coke breeze fired boilers were maintained at maximum load continuously. The load variations were followed by the purely coal fired boilers. The use of coke oven gas when available did not affect the firing of coke breeze, merely further decreasing the coal consumption and additional purchase of the latter fuel.

The recalculation of the coke breeze in terms of coal was simply a matter of form, as this fuel was received in weighed car loads and the consumption recorded as such. The charge against the boilers was made on this tonnage at an established price per ton. The converted figure along with the blast furnace and coke oven gas equivalents gave a simple record of total fuel requirements in standard terms for comparison of monthly operations, against steam production and general boiler economy.

The conversion of coke breeze into equivalent coal is a simple operation since the efficiency of the coke breeze firing in properly designed stokers and ignition furnaces was almost equal to that of coal or other fuels. It then became a matter of relative heat values and efficiencies. The heat value of coke breeze is comparatively low, owing to its high moisture and ash content when considered "as fired."

The coal equivalent of the coke breeze fired =

\[
\frac{\text{Weight of coke breeze in tons} \times 2,000 \text{ lb.} \times 8,900 \text{ B.t.u.}}{2,000 \text{ lb. coal} \times 13,500 \text{ B.t.u.}} = \text{tons of coal.}
\]

For the month under consideration on this plant, the calculations were:

\[
\frac{1,167 \times 2,000 \times 8900}{2,000 \times 13,500} = \frac{2,000 \times 13,500}{560}
\]

or 770 tons of equivalent coal for boiler house No. 4.

No tar or fuel oil is used as boiler fuel on this plant since all the available by-product tar is utilized in the open hearth furnaces and fuel oil is a purchased fuel for which there had been no set up arranged. Meters for the measurement of liquid fuels are comparatively inexpensive and would undoubtedly be utilized were such fuels used at the boiler plants. All open hearth furnaces burning tar or oil are so equipped. At the same time the plungers

<table>
<thead>
<tr>
<th>Table II—Distribution of Boiler Fuel</th>
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<td>Report No. 3 September 1930</td>
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</tbody>
</table>

- **(a) Blast Furnace Gas:**
  - In net tons equivalent coal: 4805
  - In net tons equivalent coal: 5615
  - Total net tons equivalent coal: 10420

- **(b) Coke Oven Gas:**
  - In net tons, as weighed: 4532000
  - Total net tons equivalent coal: 1154

- **(c) Coke Breeze:**
  - In net tons, as weighed: 2017
  - Total net tons equivalent coal: 1330

- **(d) Coal:**
  - In net tons, as weighed: 3184
  - Total net tons equivalent coal: 2100

*Evaluation basis on stockpile coke breeze as fired.
pumps serve as a check on the total passing through the lines and tank measurements give the total fuels delivered to the open hearth department. These tank measurements include incoming tank cars of fuel oil unloaded. The tar used as open hearth fuel is recirculated continuously in a steam heated loop with an additional steam heater at each furnace.

Were such fuels used at the boilers without metering equipment, the same method of calculation would apply as that for coke oven gas or coke breeze—on the basis of heat value and the assumption of certain efficiencies. Were several unmetered fuels such as oil, coke oven gas, tar, etc., used, some method of their separation would be required. In such cases some means of measurement of several of the unknowns would be advisable—a steam flow-meter for an individual boiler using certain fuels, a liquid meter, coal meter, or the utilization of the plunger displacement of ram type stokers, or speed and coal bed width and thickness for chain grate types, if these are fed from a central coal handling system. Fluid meters would be recommended, since calculations of a complicated mixture of fuels would result in sufficient error to render them of little actual value. Since liquid fuels are not used on the plant under discussion, their inclusion here would be purely hypothetical.

Coal

All coal, whether shipped into the plant by river boats or by rail, is delivered to the boiler coal handling equipment in cars, weighed and recorded by the transportation department and reported to the cost department as they are placed on the boiler house track. The boiler department also records the cars as unloaded, a copy of which record is forwarded to the accounting department for a daily check, so that at the end of the month the boiler house is only charged with the coal it has used. This is mentioned merely to note the fact that the switching crew may not always get the right car on the proper track and occasionally a car destined for the boilers finds its way to the gas producers, and so on; so that this check at the boiler plant is rather valuable. At the end of each month all bunkers and boiler coal storage are measured and corrections are made for unconsumed coal that has been unloaded. This tends to diminish the variation in unit fuel consumption each month as would occur if a number of cars were unloaded on the last day of the month and charged to that month’s operations although it might last a week and give an artificially low cost operation for the succeeding month.

The Boiler Fuel Report

The type of report used to show total fuel consumption of the boilers is illustrated in Table II. Copy of this report goes to the cost department for the evaluation of the various fuels used. At the same time the copy sent to the management and to the boiler and steam executives serves to visualize the fuel consumed; as locally produced by-products and the quantity of purchased fuels. The total equivalent coal is transferred to the boiler operating report for the determination of steam production economy.

Boiler House of Youngstown Sheet & Tube Company

(Continued from page 1247)

with two thicknesses of Ehret insulation; the joints are Sargol welded and the main header stop valves are Schutte & Koerting cast steel.

Instruments

Boiler operation is indicated and recorded by a complete set of instruments installed on boards erected on the firing floor. On the same board are the emergency steam valve controls. Each boiler has an individual control board on which are a draft gage, an indicating and integrating Venturi feed water recorder, and fuel and fan controls. Other instruments are:

- Integrating and recording flow meters
- Steam pressure recorder
- Steam temperature recorder
- Flow meter on 16-in. power house line
- Flow meter on evaporator and blower line
- Feed temperature recorder
- Feed pressure recorder
- Gas pressure recorder
- Pyrometers, giving temperature of air and stack gases entering and leaving air heater.

Survey for the Classification of Coal

THERE is now under way a survey from which it is hoped to develop a use classification of coals that will assist the buyer of coal to obtain the most economical coal for his requirements with the least expenditure of money and effort, and assist the seller in reducing his marketing costs by being able, thereby, to find more quickly the most profitable markets. The project is sponsored by the International Fuel Conference on Bituminous Coal, the American Society for Testing Materials and the National Association of Purchasing Agents, under the chairmanship of Thomas W. Harris, Jr., E. I. du Pont de Nemours & Company, Wilmington. The Bureau of Mines is cooperating and has distributed the questionnaire to 3500 consumers of coal.

In classifying coals, not only should the coals themselves be studied as to physical properties, rank, type, etc., but the uses of coals must also be determined if the classification is to be effective. The results of the survey will fill a long felt want of both buyers and sellers of coal.

Every user of coal for stationary steam generation is invited to participate in the survey and, on completion of the study, will receive a copy of the composite analysis of the survey.
Ohio Steel Foundry* insulates open-hearth regenerators... reduces fuel costs 23.8%

Saves

$11,579

annually

IN 1923, the Ohio Steel Foundry Company rebuilt a 25-ton—uninsulated—open-hearth furnace that had been in operation 4 years in their Lima, O., plant. The regenerators and stack flues were completely insulated with Johns-Manville Insulation.

Results were so satisfactory that in 1927 the insulation on the ends of the furnace was carried up to the top of the ports. In addition, the furnace roof over the hips at each end of the furnace was insulated.

Before insulation, 42 gallons of fuel oil were required per ton of steel. After insulation, the figure was 32 gallons.

The annual reduction in fuel consumption, which is attributed solely to the insulation, amounted to 280,000 gallons of oil—a net saving of $11,579.85. The insulation paid for itself in a little less than 3 months and has yielded a net return of 418% per year ever since.

Do you know—
of any other investment nowadays that will pay you 418% return annually?

Can you afford not to insulate? Call in a Johns-Manville engineer. Let him show you where insulation can save you the money that you waste now through unnecessary heat losses. His visit puts you under no obligation.

*Executives are invited to write for the complete Performance Report of this installation or for other reports covering specific applications in which they are interested. Just telephone the nearest J-M office or address Johns-Manville, 292 Madison Ave., New York.

Diagrammatic perspective cross section of open-hearth furnace showing Johns-Manville recommendations for insulating furnace regenerators and flues.
New Stabilizer for S-A Vibrating Screen

A UNIQUE stabilizer mounting for vibrator screens has been announced by Stephens-Adamson Manufacturing Company of Aurora, Ill.

In place of the usual balancing springs at the four corners of the screen, a simple stabilizer unit is now mounted upon one side of the frame to hold the screen at an unchanging angle. The screen is free to vibrate with the eccentric vibrating shaft, but resists the usual tendency to rock or swing out of the proper screening angle.

The stabilizer consists of two pairs of short arms, jointed elbow fashion and held parallel by a rigid cross bar. One end of each arm pivots on the flywheel housing, which is rigidly fastened to the heavy steel subframe. The other end of each arm is shackled to the screen body, as shown in the accompanying illustration.

As may be noted, the two arms are free to swing or bend in any direction, but both must bend and swing together. In operation, the movement of the stabilizer is very slight. However, it effectively prevents the annoying tendency of a vibrating screen to buck and rock when sudden loads are received.

The principal advantages claimed by Stephens-Adamson engineers for the new stabilizer are:

1—The screen body is free to vibrate, but is held positively at the desired angle.
2—The screen angle is quickly adjusted to the most effective position by loosening two bolts on one side of screen.
3—The screen has no tendency to buck or rock.
4—Subframe vibration is decreased by eliminating the reaction of the usual balancing springs.
5—The stabilizer is sturdy and durable. All arms and brackets are of cast steel and the hinge pins are equipped with Nathan automatic oil feeders, which feed oil under constant pressure to the moving surfaces, one filling of oil lasting for several weeks.

Insulating Firebrick

The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y., announces a new insulating fire brick known as the B. & W. No. 80 insulating fire brick. Although this material has been previously made experimentally, no practical method of manufacturing it in brick sizes was developed until recently. The company has now installed the necessary equipment and is producing it on a commercial scale.

This brick is a new material for furnace work. It is claimed that it is not only an insulator but is the equal of a first quality fire brick. Its insulating properties are better than a number of high grade insulators and in addition it has refractory qualities which compare favorably with any high grade fire brick.

No. 80 insulating fire brick is also superior to all others tested in point of resistance to deformation under load at high temperatures.

When used as linings for intermittent furnaces, this brick will result in very great fuel savings during the heating up periods. As an example, a furnace lined with No. 80 fire brick and designed to have the same heat flow through the walls as one lined with other fire brick will have about one-sixteenth
the heat storage capacity. As the heat storage capacity of any furnace depends on the weight of the heated furnace structure and the depth of heat penetration, it follows that since a furnace built of 18 in. of fire brick backed with 2 in. of insulating block has the same heat flow through the walls as one built of \( \frac{4}{5} \) in. of No. 80 fire brick and 2 in. of insulating block that there is a weight ratio alone of one to sixteen, or in other words, the furnace lined with No. 80 insulating fire brick has only \( \frac{6}{4} \) per cent of the heat storage capacity of the ordinary fire brick lined furnace.

A practical demonstration of this has been made with a furnace which has a wall 9 in. thick and operates with a wall temperature of 2850 deg. F. After thermal equilibrium has been reached a bare hand can be placed on the outside of the wall without discomfort, the surface temperature being about 100 deg. F.

The brick may be used without a facing of fire brick on the furnace side, exposed to furnace temperatures and gases and protected only by a coating of No. 80 cement.

The brick is suitable for lining oil and gas fired furnaces, electric furnaces of the resistance type, and for coal fired equipment wherever it may be used in protected wall areas not exposed to mechanical abrasion and slag action. These bricks are extremely easy to handle and may be cut, drilled or shaped with ordinary woodworking tools.

**Steel Mill Motor**

A NEW steel mill motor, designed for heavy duty applications, such as steel mill auxiliary drives, cranes, hoists, shovels, coal and ore bridges, mine hoists, railway turntables, transfer tables, railway lift bridges, traffic bridges, conveyors, etc., has been developed through the cooperative efforts of steel mill engineers and the Westinghouse Electric & Mfg. Company.

It has many distinctive features. The field coils and poles are positively secured to the frame without the necessity of washers or springs or other parts liable to become loose and cause damage. The improved bearing housings are securely held from turning by a clamp on each side of the housings and accommodate, interchangeably, ball or roller bearings of any standard make for grease or oil lubrication.

Deep commutator bars and wide risers permit many replacings, giving added years of commutator life. Laminated commutating poles prevent injurious sparking and give excellent performance, particularly in plugging and reversing. This construction permits high overload capacity without injury to commutator or brushes.

These motors have massive cast steel frames which are split horizontally, so the top half can readily be swung back without disconnecting any leads. The halves are hinged on self-supporting hinges on all frames, which makes convenient the removal of the armature bearings.

**Bristol’s Pneumatic Cycle Controllers**

IN the automatic control of process cycles the maximum of simplicity at a minimum of cost may generally be obtained by the use of diaphragm operated valves actuated by a pneumatic cycle controller. A very large proportion of controlled processes are such that the sequence of the several events which terminate the cycle is the reverse of their order at the beginning of the cycle. Where this condition holds, the operations may be controlled by a single cam instrument, in which a number of pilot valves are actuated in turn by a motor-driven cam. This cam may be made adjustable within certain limits; and speeds are determined by change gearing between the synchronous motor and the cam shaft. The starting and stopping of the motor are usually governed by a pressure operated switch within the case of the instrument. A single cam controller is shown in Fig. 1.
Where utmost flexibility is required, and the different events in the cycle overlap by varying degrees, rendering control by a single cam impracticable, there is available the type of instrument shown in Fig. 2. Here several individual cams are mounted on a common shaft, and each is adjustable through a wide range, both as regards the duration of its influence in the cycle and its position in the sequence of events. The pneumatic features of this instrument are identical with those of the single cam controller; but, as in the instrument illustrated, two pressure switches may be furnished where it is desired to associate the starting and the stopping of the motor with different events in the cycle.

The instruments described do not perform the function of regulation; but they may be used in conjunction with any of a variety of pneumatic or electrical regulating devices for pressure, temperature, etc.; and, with suitable accessory equipment, they readily lend themselves to those types of control where a certain degree of interlocking is required.

Automatic cycle control finds a wide application in the operation of presses and molds, and, in fact, in any industrial process where it is required that valves, or mechanisms which can be made subject to the control of valves, are required to be operated in a more or less definite sequence.

Non-Skid Safety Floor Grating

ROBERT H. IRONS, president of the Central Iron & Steel Company of Harrisburg, Pa., announces that the company has developed and placed on the market an improvement over the ordinary fabricated floor grating. It has been designated "Slotted Floor Plate."

It is claimed that the slotted floor plate is non-skid and is proof against slipping in any direction. Because of its basic design, it requires no deep recess or rabbet in which to set.

These plates can be furnished in almost any gage and size up to 72 in. by 240 in., whereas the usual fabricated grating must be made up in small sections. This greatly limits its use and usually requires a complicated and expensive supporting structure which is not required with the Central slotted floor plate.

In addition to being absolutely non-skid, this plate has all the desirable characteristics of the best in gratings. It allows free ventilation, free drainage, passage of light and reduced weight. One or more of these qualities obviously recommends its use for fire escapes and exterior platforms; flooring and galleries in industrial plants where trapped fumes, gases or heat may produce a hazard; walkways around presses where light is valuable; and any other place where gratings have heretofore been used.

Improved Dust Conditioner

THE accompanying illustration shows a Brosius flue dust conditioner, a new development for the treatment of finely pulverized material. While it was designed primarily for treating flue dust at blast furnace plants, it can, with equal facility, be adapted to dust problems in the field of non-ferrous metallurgy.

With a Brosius flue dust conditioner, the dust is conditioned directly at the dust catcher, ready for
the sintering plant. The sensible heat is removed and the dust conditioned by being passed through a rotating cage where it is agitated and mixed with water. With this conditioner, sludge water (40 to 60 per cent solids) directly from the gas cleaner equipment may be used, eliminating the filter. Any degree of moistening can be obtained by regulating the supply of water.

Practically no free dust escapes, eliminating the dust cloud which is present when emptying untreated dust, and no cleaning up is necessary. Owing to the absence of free dust the maintenance of equipment is greatly reduced. The conditioner is manufactured by Edgar E. Brosius, Inc., Pittsburgh, Pa.

Improved Scale Car

A SERIES of important new features, to meet exacting requirements, is introduced into blast furnace charging practice by the new McKee double-compartment 25-ton capacity scale car, just announced by Arthur G. McKee & Company, engineers and contractors, Cleveland.

The car is of welded construction with resulting decrease in initial cost, lessening of weight and increased stiffness, rigidity and stability.

The scales, which have been developed in the experimental laboratories of the Toledo Scale Company, are of all welded lever construction, providing minimum weight with maximum rigidity. The scale dial and recorder is 28 in. in diameter at the reading line and 34½ in. outside. Because of the fact that markers for charge increments are attached to the outside of the glass case, it is not necessary to open the case or to expose its mechanism to the dust-laden atmosphere.

The mechanism of the recorder affords a new and unusual convenience in blast furnace practice. By means of tape printing, an original and carbon copy of the recorder of each increment charge is supplied the superintendent’s office and accounting department. The scale has an attachment which prints opposite each weighing record the kind of material weighed, thus keeping an accurate record of the proper weight of each material and the sequence of charging.

Other features of the scale car include trucks of arch bar or cast steel construction built to A.R.A. standards, air operated brakes with ample size compressor and storage tanks and hopper doors operated by air.

Rotary Pug Mill

THE Caldwell Rotary Pug Mill for ore sintering plants is designed to mix and fluff ore or blast furnace flue dust in preparation for sintering.

When ore is to be sintered it must have the proper mixture of carbon, moisture and ore, in order to turn out the greatest amount of clinker. It must also be fluffed up so that a draft can be pulled through the fuel bed without drawing too much of the fine ore dust through with it.

The combination of a rotating drum with a paddle shaft revolving in the proper direction, and located at the right point, is the combination that has been developed in the Caldwell rotary pug mill.

The drum gives more space for aerating the mixture, and as the paddles have only a point contact with the drum, instead of the usual half circle, there is not the troweling effect of the stationary trough. The paddles are of a special steel hardened to resist wear, and are made removable so that they can be easily renewed. The inlet spout is made with hard liner plates which also can be renewed. The tires and trunnions are of hardened steel, and the trunnions are mounted on Timken roller bearings in dustproof housings, all constructed with a view to long life.

The speed reducer has gears of cut steel, and uses herringbone gears for the high speed set. The gears are mounted in a cast iron housing with Timken roller bearings, all running in oil, with dust seals for keeping out the dust. The slowly revolving drum is driven with a finished steel type of roller chain, using cut steel sprockets.

Information on this device can be obtained by addressing H. W. Caldwell & Son Company, 2410 West Eighteenth Street, Chicago.

Manual Across-the-Line Starter for Small Motors

A NEW three-pole, across-the-line type manual starter for all types of a.c. squirrel cage motors up to 2 hp. is announced by Cutler-Hammer, Inc., 213 North Twelfth Street, Milwaukee, Wis. Features of this new starter known as Bul. 9115, are: small size, thermal overload relays; all poles trip on overload; twin-break, silver to silver butt-type contacts; easy operation, and a 100 per cent cover interlock.

The starter is 4 7/16 in. wide, 8 9/16 in. high, and 3½ in. deep—small enough that it can be mounted directly on a machine near the operator or in any other small space. The thermal overload relays operate directly on the contact mechanism and open all three poles on an overload. These overload relays use the same heater coils as other C-H starters and are interchangeable with them.

The twin-break contact mechanism gives a double break in each line which reduces the voltage rise and consequent arcing, when opening the circuit. Silver-to-silver contacts maintain their current carrying capacity and prevent pitting.

The cover interlock prevents opening the enclosing case if the motor is running—the operating lever must first be returned to the “off” position. It also allows padlocking the enclosing case and the operating lever in the “off” position, or the enclosing case only can be padlocked.
A.S.A. Approves Personnel for Foundry Safety Code

The personnel of the committee preparing the revision of the Safety Code for the Protection of Industrial Workers in Foundries (18-1922) was approved by the A.S.A. Standards Council at its meeting on June 8, 1931. This code is being prepared under the sponsorship of the American Foundrymen's Association and the National Founders' Association. The cooperating bodies, in addition to the sponsors which have appointed representatives on the committee, are:

- American Society of Mechanical Engineers
- American Society of Safety Engineers—Engineering Section, National Safety Council
- Association of Governmental Officials in Industry
- Cast Iron Pipe Research Association
- National Association of Manufacturers
- National Association of Mutual Casualty Companies
- National Bureau of Casualty and Surety Underwriters
- National Founders Association
- National Safety Council
- National Safety Council Equipment Manufacturers Section
- Pennsylvania Department of Labor and Industry
- Steel Founders Society of America
- U. S. Bureau of Standards
- U. S. Department of Labor
- U. S. Bureau of Public Health Service
- W. C. Wright, a foundry consultant, is serving as a member-at-large.

The original code for this project was approved in 1922 as American Tentative Standard. The present revision is intended to bring the code up-to-date and advance it to American Standard. The temporary committee, while waiting for approval, has been at work on the revision and the work is far enough advanced that the final draft will be completed within the next two months.

Awarded Trophy

Black & Decker Manufacturing Company, Towson, Md., has been awarded a bronze trophy by the Baltimore Safety Council for the best record for the past six months among 79 manufacturing plants in and about Baltimore in the elimination of lost-time accidents. This company had no lost-time accidents in this period. Safety appliances on all machinery, efficient first-aid and measures to produce contentment and eliminate fatigue are among the measures employed to avoid injuries.

Safety Code Committee Elects New Officers

At its recent meeting held in New York, the Safety Code Correlating Committee of the A.S.A. elected officers and members of the executive committee for the ensuing year.

The chairman is J. A. Morford, director of the Field Research Bureau of the National Industrial Conference Board. Mr. Morford has been serving during the past 18 months as chairman of the subcommittee on promotion of the use of safety codes in industry.

Walter Paine, director of the engineering and inspection bureau of the Aetna Insurance Company, was elected vice chairman. Mr. Paine has been a very active member of the committee for several years.

The executive committee, in addition to the officers, includes:

- Dr. L. W. Hatch, member, Industrial Board, New York Department of Labor, New York.
- L. W. Adams, General Electric Company, Schenectady, N. Y.
- T. P. Kearns, director, Safety Division, Industrial Commission of Ohio, Columbus, Ohio.
- W. D. Keeler, director, Industrial Division, National Safety Council, Chicago, Ill.

Steel Industry Accident Statistics

Injury experience in the steel industry had two outstanding characteristics in 1930: first, the 1930 frequency rate was lower than in most industries, but the severity rate was higher; and second, the industry reduced both of these rates more rapidly than most other industries. One hundred and twenty-five plants with 458,000,000 man-hours exposure during 1930 averaged 11.99 lost-time injuries per million hours worked and 2.47 days lost time per thousand hours worked. The frequency rate was 35 per cent below the 18.47 for all industry, while the severity was 25 per cent higher than for all industry. The steel industry ranked fifth in frequency and twenty-second in severity among 28 major industrial groups. The 1930 exposure was well below the 567,000,000 man-hours reported by 128 plants in 1929.

Progress in safety was shown by a 39 per cent decline in frequency and 15 per cent in severity.
TRADE NOTES

The Factory Stores Company, Euclid Seventy-First Building, Cleveland, Ohio, on August 1 took over the office and mill restaurant of the A.M. Byers Company at Ambridge, Pa. The Factory Stores Company also opened a lunch room on August 24 at the Cleveland, Ohio, plant of the Columbia Axle Company.

Harry S. Braman has been appointed sales representative of the Standard Alloy Company of Cleveland, Ohio, in the Youngstown and Pittsburgh districts. Mr. Braman has opened an office at 1403 Central Tower Building, Youngstown, Ohio.

Shook & Fletcher Supply Company, Brown-Marx building, Birmingham, Ala., has been appointed southern sales agent for Mackintosh-Hemp hill Company of Pittsburgh, Pa. This company will handle rolling mill machinery as exclusive agents in the following states, viz: Tennessee, North Carolina, Georgia, Florida, Alabama and Mississippi. This was effective August 1, 1931.

Lukenweld, Inc. (division of Lukens Steel Company, Coatesville, Pa.), has appointed W. R. McDonough & Company as its representative in the Cleveland district.

On August 1, 1931, the Cooper-Bessemer Corporation repurchased the Chapman gas producer division of the former Chapman-Stein Company which was acquired in October, 1930, by the Surface Combustion Corporation of Toledo, Ohio.

Chapman gas producers make gas from coal for use in gas burning furnaces in many industries. Because the Surface Combustion Corporation specializes in the manufacture of natural gas burning appliances, it was found advantageous to resell the gas producer division of the Chapman-Stein Company, which also includes Chapman floating agitators, to the Cooper-Bessemer Corporation.

This transaction involves no change in manufacture because Chapman gas producers have always been and will continue to be built in the shops of the Cooper-Bessemer Corporation.

The Cincinnati Milling Machine Company and Cincinnati Grinders Incorporated, manufacturers of milling and grinding machines, announce direct sales representation in the Detroit, Chicago, Cleveland and Cincinnati territories. As a result of the increasing demands coming from users of machine tools in these territories for field technical service direct from the plant, this new direct factory representation will soon be put into effect.

Engineers, long technically trained and thoroughly experienced in milling and grinding meth-
equipment requirements of contractors, railroads, utilities and industrial users.

Worthington's feather valve compressors always have been an integral part of Metalweld portable units. It is a natural step, therefore, for Worthington to acquire the manufacture of the complete product. The portable compressors will be manufactured at the Harrison, N. J., works of the Worthington Pump & Machinery Corporation, and the engineering, manufacturing and sales personnel of the Metalweld organization also will be located there.

Lukenweld, Inc. (division of Lukens Steel Company, Coatesville, Pa.), has appointed the Dravo Doyle Company as representative in the Pittsburgh territory. The Dravo Doyle organization, because of its extensive experience in sales and engineering work for prominent manufacturers of machinery and equipment, is well equipped to serve Pittsburgh industries in connection with sales and engineering work on Lukenweld construction.

**PUBLICATIONS**

Ball and Roller Bearings—A Handbook for Designers and Engineers, titles a book upon ball thrust and radial roller bearings which has just been published by the Aetna Ball Bearing Manufacturing Company, 4600 Schubert Avenue, Chicago, Ill. This book, the ninth edition of their catalogue, consists of 68 pages. A number of interesting applications of thrust and roller bearings, together with typical mountings for both types of bearings are shown, for carrying unidirectional thrust as well as thrust from two directions. A number of valuable formulas are presented for calculating horsepower, torque, the end thrust of worms and gears, and end thrust of bevel gears, plain, bevel, spiral and hypoid gears. The complete line of Aetna thrust bearings, retainers and roller bearings are given in condensed form, including their load carrying capacity at various speeds, together with three complete series of roller bearings for light, medium and heavy duty. The book, especially designed for use by designers and draftsmen, measures only \( \frac{2}{7} \) by \( \frac{7}{4} \) in. Copies may be obtained by writing the company.

Automatic Safety Shut-Off Valves is the title to a pamphlet now being distributed by the North American Manufacturing Company, 2916 East Seventy-fifth Street, Cleveland, Ohio. The pamphlet describes the operation and construction of a valve for closing the fuel line should either the flow of fuel or air fail. In addition to a description of the valve its design is clearly shown by illustrations. The prices of several sizes are given.

The Westinghouse Electric & Manufacturing Company announces the publication of a booklet covering types GO, GO-1, and GO-2 oil circuit breakers, a line of low-capacity outdoor breakers for use in distribution or low-voltage transmission systems. Construction and operation details, style numbers, and a number of illustrations are included among the contents of this publication, which is identified as Circular 2121.

The Truscon Steel Company, Youngstown, Ohio, has issued an 8-page folder which concerns Truscon safety-tread steel for floors, walks, ramps and crossings. This publication describes and illustrates applications for plates, paving blocks, planks, etc., of all-steel construction as manufactured by the company.

Received from the Reeves Pulley Company, Columbus, Ind., is a 6-page folder which describes an improved variable speed unit manufactured by the company. The operating principles and construction details are given. Numerous illustrations supplement the text.

The C. J. Tagliabue Manufacturing Company of Brooklyn, N. Y., well known makers of instruments for indicating, recording and controlling temperature and pressure in industrial processes, has announced the completion of a general catalog. This catalog, which consists of more than 100 pages, places under one cover the complete line of Tag controllers, recorders, dials, thermometers, hydrometers, oil testing instruments and moisture meters.

Appropriate classifications of the many groups of instruments have been carefully considered and there are many applications of these instruments accurately described and completely listed.

A bulletin has been issued by W. A. Jones Foundry & Machine Company on their new double reduction Herringbone-Maag speed reducers for small motor drives. In design, construction and manufacture, these small machines are the same as its heavy duty reducers. Double helical gears, accurately generated right and left hand, in effect a herringbone gear with a wide gap, are used for the initial, or high speed, reduction. The low speed reduction consists of an accurately generated Maag pinion and gear. Timken bearings are used throughout, assuring complete anti-friction mounting.

An extensive list of ratios is carried in stock to assure prompt deliveries. To those who are interested in small Herringbone-Maag reducers, the manufacturer, W. A. Jones Foundry & Machine Company, 4401 West Roosevelt Road, Chicago, Ill., will be glad to send this descriptive bulletin No. 53.

The Inland Steel Company announces for distribution a new edition of the booklet "Inland Open Hearth Sheet Steel Products."

The booklet contains all the information, brought up to date, ordinarily needed for ordering steel sheets, the company states. Standard extra and dif-
differentials, sheet weights, and bundling tables, stand-
ard commercial tolerances, and trade customs and
practices are included as well as descriptions of all
Inland sheet steel products.

The booklet is coatpocket size and contains 56
pages.

A four-page folder issued by the Elgin Softener
Corporation, Elgin, Ill., gives a complete description
of the Elgin continuous blowdown system. Diagrams,
which supplement the text, show the construc-
tion and operation of the system.

Received from the Morse Chain Company, Ithaca,
N. Y., is Bulletin No. 44, a 56-page catalog which
contains complete information concerning Morse
stock drives up to 50 hp., together with list prices.
Chain cases, sprockets, hunting links, and installa-
tion and lubrication data are also covered.

The Farrel-Birmingham Company, Inc., Ansonia,
Conn., has issued a 24-page booklet titled "Assuring
Production with Precision in Roll Grinding." This
publication explains the necessity for close accur-
acy and fine finish in rolls used for the manufacture
of various products such as metal, paper, rubber,
etc., and how the skill transferred into the mechan-
ism of Farrel roll grinders permits the highest at-
tainment of these requirements with a minimum of
dependence upon human skill.

The mechanical features responsible for the ac-
curacy and high output of finished rolls are de-
scribed and illustrated. These features are respon-
sible for substantial improvement in the quality of
roll grinding and, in many cases, the reduction of
roll finishing costs.

Leaflet No. 2135, issued by the Allis-Chalmers
Manufacturing Company, Milwaukee, Wis., is titled
"Frog Leg Armature Windings." This publica-
tion describes and illustrates such windings and explains
their application and advantages.

The National City Company has prepared a book-
let outlining the plants and organization of National
Steel Corporation. The booklet points out that the
formation of National Steel has been an integrating
rather than a merging process, each unit continuing
under substantially the same management which
has been responsible for its record to date. More-
over, each unit operates, more or less, as an indi-
vidual undertaking but with a high degree of cen-
tralized control as to general policy and program of
operation.

Constituent companies of National Steel Com-
pany are Weirton Steel Company, Weirton, W. Va.;
Great Lakes Steel Corporation, Detroit, Mich.;
Midwest Steel Corporation, Chicago; Weirton Coal
Company, owning 7,000 acres of coal lands in Fay-
ette and Washington counties, Pa., and Brooke
County, W. Va.; Hanna Furnace Corporation, Det-
troit; Hanna Iron Ore Company, Cleveland; Michi-
gan Division (formerly Michigan Steel Corpora-
tion) of Great Lakes Steel Corporation, Detroit;
and the Producers Steamship Company, Cleveland.

COMING
MEETINGS

Sept. 6-12—International Association for the
Testing of Materials. First international congress
to be held at Zurich, Switzerland. Information on
the meeting may be obtained from C. L. Warwick,
1315 Spruce Street, Philadelphia.

Sept. 7-11—National Association of Power Engi-
neers. Annual convention and mechanical exposi-
tion at convention hall, Kansas City, Mo. Secretary,
Fred W. Raven, 417 South Dearborn Street, Chi-
cago.

Sept. 13-15—British Institute of Metals. Annual
autumn meeting at Zurich, Switzerland. Secretary,
G. Shaw Scott, 36 Victoria Street, Westminster,
London, S. W. I.

Sept. 17—Steel Founders' Society of America,
Inc. First fall meeting to be held at Chicago. Man-
aging director, Granville P. Rogers, 932 Graybar
building, New York.

Sept. 21-25—National Metal Exposition. Thir-
teenth annual exposition to be held on Common-
wealth Pier, Boston.

Sept. 21-25—American Welding Society. Semi-
nannual meeting in Boston. Secretary, M. M. Kelly,
33 West Thirty-ninth Street, New York.

Sept. 21-26—American Society for Steel Treating.
National metal congress and exposition to be held
at Commonwealth Pier and Hotel Statler, Boston.
Secretary, W. H. Eisenman, 7016 Euclid Avenue,
Cleveland.

meeting and exposition at Stevens Hotel, Chicago.
Secretary, W. H. Cameron, 20 North Wacker Drive,
Chicago.

Oct. 15-16—Gray Iron Institute. Fourth annual
convention to be held at West Baden Springs Hotel,
West Baden Springs, Ind. Secretary, J. Arthur Tus-
cany, Terminal Tower, Cleveland.

Oct. 22—Steel Founders' Society of America, Inc.
Meeting to be held at New York. Managing direc-
tor, Granville P. Rogers, 932 Graybar building, New
York.

Nov. 30-Dec. 5—American Society of Mechanical
Engineers. Annual meeting to be held at Engineer-
ing Societies building, New York. Secretary, Calvin
W. Rice, 29 West Thirty-ninth Street, New York.
News of the Plants

J. D. Waddell, Niles, Ohio, formerly vice president of Empire Steel Corporation, Mansfield, Ohio, now in receivership, is arranging to purchase, with a group of associates, the Waddell plant in Niles, a unit of the Empire Company, and perhaps the two other Niles properties of the company, it is reported in Youngstown.

Mr. Waddell formerly operated the Waddell Steel Company, a non-integrated sheet rolling interest with six mills, which became a part of the Empire Company when that organization was formed. The latter company also owns the Falcon and Thomas plants, both sheet producers. All three of the Niles properties have been idle since the Empire Company was forced into receivership.

Mr. Waddell plans to form a company to operate the properties which are acquired. Because these plants have no steel supply, it will be necessary to purchase sheet bars on the open market.

Some of the Empire plants now are being operated under receivership.

* * *

Officials of the Bethlehem Steel Corporation deny that the company is negotiating for the acquisition of the Woodward Iron Company or any other Alabama iron and steel company.

Rumors also have been current locally that Bethlehem has taken over the Eaton-Otis stock interest in Gulf States Steel Company, Birmingham, Ala.

* * *

British steel output in July was 428,700 tons, against 428,900 in June, and 621,400 in July, 1930. Iron output was 317,000 tons, against 323,800 in June, and 486,100 in July, 1930. The average monthly steel output in 1930 was 608,200 tons, and the average monthly iron output was 516,400 tons. The number of furnaces working at the end of July was 70, a decrease of six in the month.

* * *

Chicago Railway Equipment Company, division of Franklin Steel Works, has started work on 10,000 steel brake beams for the Erie Railroad. This is the largest order the Franklin plant has received in three years. One mill will be provided with work for three months.

* * *

After having produced 801,230 tons of pig iron on the original lining, during a period of almost five years, the stack of the Mystic Iron Works at Everett, Mass., was blown out August 1.

There is no date set for the starting of the stack again. During the shutdown the furnace will be relined and thoroughly overhauled.

In the five years that the furnace was in operation it is reported that the amount of raw materials used was as follows: iron ore, 1,358,970 gross tons; coke, 778,541 net tons; limestone, 152,250 gross tons.

* * *

Negotiations are in progress which are expected to eventually result in the acquisition of a controlling interest in the National-Erie Company, manufacturer of steel castings of all kinds and various types of gears, by the Bucyrus-Erie Company, manufacturer of steam shovels, excavating machinery and contractors' equipment.

During normal times a major portion of the output of the National-Erie Company is utilized by the local plant of the Bucyrus-Erie Company. Passing of the dividend on common stock of the latter concern is seen in local business circles as paving the way for providing funds with which to acquire the National-Erie Company.

* * *

A. M. Byers Company, Pittsburgh, manufacturer of wrought iron products, has taken a six months' option to purchase the Canonsburg Steel & Iron Works, Canonsburg, Pa., maker of black and galvanized sheets. The Canonsburg company, which is controlled by the Edwards Manufacturing Company, Cincinnati, was founded in 1902 and has an annual capacity of 38,000 tons of black sheets and 16,000 tons of galvanized sheets. It is understood that the company will roll wrought iron sheets in an experimental way for the Byers organization over the next few months.

* * *

On August 1, 1931, the Cooper-Bessemer Corporation repurchased the Chapman gas producer division which was acquired in October, 1930, by the Surface Combustion Company of Toledo, Ohio.

This involves no change in manufacture because Chapman gas producers and Chapman floating agitators have always been and will continue to be built in the shops of the Cooper-Bessemer Corporation.

* * *

The Pressed Steel Car Company of Pittsburgh, manufacturers of railroad cars, has awarded the contract for the design and construction of a new Chicago plant to The Austin Company, engineers and builders of Cleveland. The contract includes six buildings to be erected at 136th and Brandon Streets, in Chicago, replacing the former plant of the company destroyed by fire.

All buildings will be one-story steel and brick construction, the largest being 90 ft. wide and 360 ft. long. A total of 280 tons of structural steel will be required. All work is expected to be completed in September. The project represents an investment of $60,000.
WHY...

"No Steel Product is Sounder than the Ingot from which it is Produced"

A BEARING, a bolt, an axle, a column, a rail, a plate or a sheet — none is sounder or more reliable than the ingot from which it was rolled.

- For neither exterior nor interior defects — pipes, blowholes, shrinkage cracks, seams — can be reliably welded at the temperatures used in reducing an ingot to a bloom or slab.

- Thus the necessity for soundness in the ingot is fundamental.

- For years Gathmann Big-End-Up ingots have been the standard of quality in killed steel production; more than 30,000,000 tons of reliably sound products have been rolled from Gathmann-designed sinkhead ingots within the past ten years.

Now...

thru a new method of stripping, Gathmann has made possible the economical production of open and rimming steel in Big-End-Up molds. A model of the invention will be shown in operation at our booth at the National Metal Exposition. Our booth number is D-91.

THE GATHMANN ENGINEERING COMPANY

"DESIGNERS OF INGOT MOLDS SINCE 1909"

BALTIMORE • MARYLAND
Jesse F. Welborn, chairman, Colorado Fuel & Iron Company, Denver and Pueblo, Colo., has been appointed to an unemployment relief committee by the mayor of Denver.

William H. Crosby, formerly president of the Crosby Company, sheet metal stampings, Buffalo, has been elected chairman. Henry W. Crosby, formerly secretary, now is president; Edward S. Gram is vice president; John M. Smith is treasurer; Howard W. Kurtz, formerly assistant engineer, now is assistant treasurer; Fred C. Burkhardt, chief engineer, now also is secretary; Charles L. Sager is assistant secretary, and Charles J. Pankow is superintendent.

Otha Lewis, for three years past in charge of the warehouse at Memphis, Tenn., of Wheeling Steel Corporation, Wheeling, W. Va., has been appointed foreman of the galvanizing shipping department at its Portsmouth, Ohio, plant.

Harry M. Jefferson of Wheeling and formerly of Portsmouth, has been appointed to succeed Mr. Lewis at Memphis and has taken on other duties there.

L. S. Hamaker, advertising manager of Republic Steel Corporation, became manager of sales promotion effective August 1, according to an announcement by N. J. Clarke, vice president in charge of sales. Mr. Hamaker will assume his new duties immediately, making his headquarters at Youngstown.

R. R. Davis, who has directed, in the past 21 years, various Westinghouse advertising activities, has been appointed apparatus advertising manager of the Westinghouse Electric & Mfg. Company at East Pittsburgh. He will have charge of all apparatus advertising activities of the company except the merchandising department, headquarters for which are located at Mansfield, Ohio.

William W. West, for several years general superintendent of Steel & Tubes, Inc., Elyria division, and formerly superintendent of the mills and roll department of the same company, has tendered his resignation. Mr. West’s experience prior to his association with Steel & Tubes, Inc., was obtained in the Gautier plant of the Cambria Steel Company, where he superintended the rolling of shapes of alloy, high and low carbon steel; and at plants of the Colorado Fuel & Iron Company and the Pittsburgh Crucible Steel Company.

Louis J. Voyler, who in April of this year was appointed district manager of sales at Youngstown, Ohio, for Newton Steel Company, Newton Falls, Ohio, and Monroe, Mich., has been made district manager of sales at Cleveland, succeeding F. C. Flood, resigned. Mr. Voyler has been with the company since August, 1925, when he was placed in charge of the New York sales office, succeeding H. D. Eller. Mr. Voyler formerly had been secretary and general sales manager of Ohio Corrugating Company, Warren, Ohio, going there in 1919 from Liberty Steel Company, Warren, where he had been in turn assistant general manager of sales and general manager of sales from early 1918 to June, 1919.
PRINCIPAL among the reasons for the outstanding performance of the modified Bigelow Arch in this difficult service in a middle western steel mill is the pendulum suspension of each individual arch tile. As shown by the detail photograph, each tile is suspended from a separate steel hook—consequently, there can be no cumulative loading of the refractory and every tile is free to expand and contract without imposing stress on any other tile. Any tile can be removed and replaced without disturbing adjacent tile; this minimizes the amount of refractory used for replacement.

Another important reason for the success of the modified Bigelow Arch is the refractory used—a special Bigelow-Liptak bung mix that gives unusual resistance to spalling.

Bigelow Unit-Suspended Arches and Walls are also very successfully used in billet heating furnaces, boiler furnaces, etc. Information will gladly be furnished regarding their application to your own furnace requirements.

BIGELOW-LIPTAK CORPORATION
5061 WOODWARD AVENUE, DETROIT, MICHIGAN


Name on request

BIGELOW-LIPTAK
A SUSPENDED WALL AND ARCH FOR EVERY FURNACE
William J. Gibney has severed his connection with Bingham & Taylor, Buffalo, of which firm he was vice president, and has become affiliated with the Strong Steel Foundry Company, Buffalo, as assistant to the president.


H. O. McCully is now president of the Erie Bolt & Nut Company, Erie, Pa., succeeding Lincoln Davis, who has retired from active participation in the business.

George C. McCormick, chief engineer, General Alloys Company, Boston, Mass., has been elected a vice president of that company.

Leo G. Hall has been appointed to the staff of Ryerson Physical Laboratory at the University of Chicago, in connection with experimental research in metals and alloys for optical purposes. Mr. Hall will continue his private consulting practice on problems and designs connected with high temperature, high pressure, and suitable electro-chemical technique and apparatus.

C. E. Stephens, vice president, Westinghouse Electric & Manufacturing Company, has announced the appointment of T. R. Langan as northeastern district manager of the Westinghouse organization with headquarters in New York City.

E. H. Mebs has been made chief metallurgist of the Ohio Steel Foundry Company, Lima, Ohio. He formerly was metallurgist at the Watertown, Mass., arsenal of the United States army. Previously he had been connected with the Wheeling Mold & Foundry Company, Wheeling, W. Va., for eight years.

William Vogt and Chester A. Porter sailed July 7 en route to the U. S. S. R. to join the Kuznetsk organization of the Freyn Engineering Company. Ralph Vaill, J. S. Ferguson, C. C. Boucher, George T. Chapman, Herman F. Reinke, Bruce E. Tau and James C. Thompson sailed July 18 on the Bremen en route to the U. S. S. R. also to join the Kuznetsk organization of Freyn Engineering Company which is engaged in designing and building a complete steel plant having an annual capacity in excess of one million tons.

Bruce O. Strachan of Ely, Minn., has been appointed general superintendent of the Vermilion range for Oliver Iron Mining Company, Duluth. He succeeded the late Charles Trezona. Mr. Strachan started with the Oliver company in 1906 as mining engineer. Four years later he was made chief mining engineer and in 1919 was appointed superintendent.
This particular ATLAS car is used to transport coke from the wharves to the blast furnace bins, and is of the side dump type, with two separately operated discharge gates controlled by compressed air. Brick is used for the bottom of the car to resist abrasion of the sliding coke, sides and ends of the car lined with high carbon steel plates.

At each end of the car is an operator's cab so that the operator can always be in front of the car when traveling in either direction.

Roller bearings reduce to a minimum the power required to start the car, and cut maintenance expense.

ATLAS Dial Scales give absolute accuracy and dependability in weighing.

Write for Bulletin.

THE ATLAS CAR & MANUFACTURING CO.

Engineers

Cleveland, Ohio

Manufacturers

---

Uniformly Rich Gas at Low Cost

The uniform distribution of fuel in small quantities by the gastight coal feeder; the constant mechanical agitation of the entire fuel bed resulting in rapid gasification and the continuous ash removal which maintains the fuel bed at a constant level, are the operation features of the "WOOD" fully Automatic Gas Producers which ensure a steady flow of uniformly rich gas at low cost. As operation is automatic, labor charges are reduced to the minimum. The large gas output decreases the number of producers required. The cost of maintenance is almost negligible.

Write for full information. We will arrange for you to inspect an installation in regular operation, where these advantages will be demonstrated.

R. D. WOOD & COMPANY

PHILADELPHIA

Designers and Builders of Mechanical Gas Producers since 1889
Sheet and Tinplate Rolls*

By J. Selwyn Caswell
M.Sc., A.M.I.Mech.E.

The following notes refer to an investigation which was undertaken for the purpose of determining the distribution of the roll loads and stresses and the causes of roll breakage in sheet and tinplate mills.

The loads and the working conditions are very severe, and a roll may be broken within a few hours after it has been put into service. The premature failure of rolls is one of the most disturbing factors in the sheet and tinplate industry, and in some cases roll breakages have been the direct cause of bankruptcy. It is not so much the loss of the roll that is serious, but rather the disorganization of the plant and the consequent loss of output which accompanies it.

The investigation covers the manufacture and the use of the rolls, and the subject is discussed under the following main headings:

- The foundry stresses.
- The load stresses.
- The thermal stresses.

The work necessitated the collection of the essential data in the foundry and the mills, and also the determination of the physical properties of roll iron.

The writer could not have proceeded with the work without the kind cooperation of roll makers and roll users and the ready assistance of Professor Bacon in allowing him to purchase the necessary instruments through the engineering department of the college. It is with pleasure, therefore, that the writer records his indebtedness to Professor Bacon and to the following:

- Messrs. Welsh Plate and Sheet Manufacturers’ Association, Swansea, and the officials and workmen who have assisted the writer in the collection of the necessary data.

The subject of roll breakage is complicated by the fact that it is impossible to determine the value and distribution of the internal stresses, which are set up when a roll is made. Roll-making is a special art, requiring long experience and thorough metallurgical knowledge. Surface cracks, and even fractures, may occur as a result of internal stress alone, before the roll has left the foundry, or it may be that the heating and loading of the roll during the early stages of its life, may suffice to overcome the remaining stress capacity of the roll.

The object of these articles is to discuss the stress conditions in the rolls, and also to indicate the causes of breakage.

Roll Breakage Records

It was considered that a representative record of roll breakages would provide interesting, as well as useful, information in this investigation.

Isolated records, collected in a small works, are of little use for the purpose of making general deductions, because they are affected by local conditions. The effect of local conditions can be diminished only by collecting a large number of records from several works.

The Welsh Plate and Sheet Manufacturers’ Association very kindly cooperated with the writer for the purpose of obtaining a suitable record, and the writer desires to record his thanks to Charles G. Gilbertson, J.P., and the secretary, H. C. Thomas, for their kind help in this direction. A number of sheet and tinplate works were invited to send in a monthly return giving complete information on roll breakages, and a request was made that the returns should be sent in over a period of twelve months in order that a complete cycle of the seasons should be covered.

The returns were collected during the whole of the year 1928. The number of broken rolls represented by the returns was 182, and the mill units concerned were respectively 29 sheet mills and 28 tinplate mills distributed over nine works. The record is not, unfortunately, as large as one would wish it to be, but it was the largest record which could be obtained under the circumstances.

*Abstract of paper before the South Wales Institute of Engineers, 1930. For the full text of the paper, see Proc. South Wales Institute of Engineers, v. 46, p. 310-432.

(To be continued)
The ingot turning machine illustrated at the left is installed in the 40" blooming mill of a nationally known steel company.

It is designed to pick up blooms, ingots, billets, and the like from the roll table and reverse them so that the operator may introduce the desired end into the rolling mill. The device is completely operated by one motor.

Lewis builds a complete line of rolling mill equipment, rolls, shears, and special machinery for steel fabrication. Your inquiry is solicited.
Babcock & Wilcox Company Appoints Distributors

The Babcock & Wilcox Company announces that Fred Sprinkman & Sons, 116 South Second Street, Milwaukee, Wis., have been appointed distributors of B & W No. 80 refractory mortars and plastics for that district.

Organize New Castle Hot Top Company

Application for a charter has been made by the New Castle (Pa.) Hot Top Company, which is headed by R. W. Rowland, president of the New Castle Refractories Company, and R. W. Porter and C. E. Lott.

The new firm will be operated as a subsidiary of the New Castle Refractories Company and will manufacture hot tops and other refractory products.

Clay Products Firms Merge

The Laclede-Christy Clay Products Company, St. Louis, Mo., has acquired the assets and business of the Walsh Clay Products Company of St. Louis, a subsidiary of the Mississippi Glass Company, and the Buckeye Clay Products Company of Toledo, Ohio.

The negotiations have been carried on through the Collin & Norton Company of Toledo, Ohio. The transaction is subject to ratification by the stockholders of Laclede-Christy.

The acquisition of these two plants, under one management and control, will provide greater efficiency in operation and larger appropriations for scientific research work in refractories. The Laclede-Christy Company has for a great many years held a Fellowship in the Mellon Institute for research work in refractories for glass manufacture, and has also conducted its own laboratory with a large personnel at one of its plants in St. Louis. It is planned to increase these facilities, and the result is expected to be greatly increased service and facilities for taking care of the refractories requirements of glass manufacturers as well as other industrial concerns.

It is contemplated that the executive officials of the Buckeye Clay Products Company will be retained, as well as some of the personnel of the Walsh Company. Wm. K. Brownlee and A. S. Zopfi of the Buckeye Company will become members of the Laclede-Christy organization.

Furnace Walls*

By George P. Reintjes
President of the George P. Reintjes Company

The refractories in brick walls of furnaces used for heating purposes, whether that heating be of water, oil, or metal, consist principally of a combination of alumina and silica, while the brick of furnaces used for melting purposes are made of silica.

Refractory clays are found in various places throughout the world in the form of alluvial deposits. In the course of the writer's experience as a furnace mason contractor, he has made a careful study of these deposits, especially of those in the North Central Missouri section which are considered to be among the purest and most uniform to be found anywhere.

However, even in North Central Missouri, there is a wide difference in the uniformity of the clay deposits. These clays are deposited in beds ranging from 5 ft. to 50 ft. in thickness, and vary from 10 ft. under the ground at the west end of the deposit to over 100 ft. below the surface at the east end of the area. Parts of the area underlying the refractory clays are very rough and hilly, while other sections are comparatively level.

*This is the second of a series of articles by Mr. Reintjes on the subject of furnaces and refractories. The first appeared in the June, 1931, issue.

Henry Rohde, brick mason superintendent at the Franklin plant of the Bethlehem Steel Corporation, Johnstown, Pa. For 42 years he has been in service at this plant.
Improved Lavino Chrome Brick
—in the Basic Open Hearth

Economical applications of IMPROVED Lavino Chrome Brick in Open Hearth with sloping backwall. The layer of Kromepatch-Neutragrog between the brick bottom and Grain Magnesite provides a dense, monolithic section to protect the brick joints against metal penetration.

Use IMPROVED Lavino Chrome Brick in place of Magnesite Brick. The saving in first cost is between $65.00 and $70.00 per thousand in favor of Chrome Brick. A superior product for less money.

The use of Prepared Lavino Chrome Ore (applied before heating up) on sloping backwalls between the Lavino Chrome Brick and Dolomite or Grain Magnesite is standard practice with many well-known steel plants.

Efficiently operated Open Hearth plants, not bound by precedent and old-fashioned ideas, have been quick to realize the greater utility, economy and superior excellence of Lavino Chrome Brick.

Complete bottoms of Lavino Chrome Brick have been in operation for more than nine years, effecting unusual economies in maintenance and repairs, in addition to thousands of dollars saved on the initial installations.

Many plants have also found it profitable to use Lavino Chrome Brick instead of Silica in front- and backwalls.

It is truthfully said that Lavino Chrome Brick revolutionized construction of the basic Open Hearth Furnace and now that brick has been greatly improved.

Research brought to light the cause of inherent weaknesses in all chrome brick. A process developed by Lavino Engineers has corrected these weaknesses. The result—IMPROVED Lavino Chrome Brick.

Users of IMPROVED Lavino Chrome Brick are convinced they are superior to Magnesite Brick in any part of the basic Open Hearth and initial service records show a life of from 80% to 100% greater than any other chrome brick.

Consult one of our refractories engineers on all new applications of IMPROVED Lavino Chrome Brick. Our men are trained to recommend only applications which can be supported by laboratory or performance records.

E.J. LAVINO AND COMPANY
REFRACTORIES DIVISION
CHROME, MAGNESITE AND SILICA REFRACTORIES
BULLIT BUILDING PHILADELPHIA

"Pioneers in Chrome Refractories"
deposits were made during the Glacier Period, the clays being carried down from the Mesabi Range and deposited in this area. These deposits were made after the hills and valleys were formed, as they follow the contour of the ground. They were made apparently in two periods, the higher quality clays being in the lower strata and the lower quality clays in the upper strata. When the deposits were made in the hilly sections, possibly owing to eddying, the purer clays were deposited in the smaller ravines or valleys and the clays not so free of impurities were deposited in the broader valleys. This is comparable to coarse and fine gravel beds in a river stream.

No. 1 quality clays are very light in color, whereas the second quality clays range from a darker shade to almost black. The No. 1 quality or the lighter colored clays range from a pure flint clay to those of a semi-flint nature. Where the pure flint clays are encountered, bonding clays are added. Another method commonly used where there is a deficiency of bonding clays, is to allow the brick to remain under pressure in the dry press machine for a longer period to assist in tying the particles together.

I have been speaking of the North Central Missouri field. At St. Louis, the famous Cheltenham clays have been used for many years. At the present time, however, very little Cheltenham clay is used for the first quality brick. Practically all of the manufacturers of fire brick at St. Louis ship their high quality clays to their plants from deposits in the interior of the state, using the local clays only as a bonding clay and for the second quality brick.

The proportion of second quality clays to first quality clays in the deposits is not constant, but varies very materially. It may range from 20 per cent second quality and 80 per cent first quality to 60 per cent second quality and 40 per cent first quality in clays within a few feet of each other.

For this reason, and also because the beds follow the contour of the hills, where the overburden is not excessive, it has been found much more practical to procure the clays by removing the overburden, taking out the second quality clays and then the first quality clays.

Where the overburden ranges from 60 ft. to 100 ft., recourse must be had to the shaft and room method of mining. A formation of coal ranging from a few inches to several feet in thickness almost invariably overlies the clays in the deeper deposits, and is left there to form a roof when mining. The room and shaft method of mining is only practical where the contour of the land is comparatively level.

Considerable ingenuity is required when removing the clays by the room method; first and second quality clays must be separated, and the coal must be kept out of the clays. It is imperative that the two qualities of clays be separated, not only because of their difference in service, but principally because of their difference in their shrinkage when burned would make ununiform brick.

The principal manufacturers in Missouri use similar processes and equipment in the treating and manufacture of the brick; namely, the clays after leaving the mine or pit are brought to the desired fineness for the particular brick, blended with other clays or with a proportion of calcined clays to control the shrinkage, compressed in a dry press machine, and burned in a tunnel kiln.

Because of the variation in shrinkage of the clays as they are mined, the different proportion of bonding clays to the flint clays, and the varied moisture content, great credit for uniformity in brick must be given to the plant operator and the plant ceramist. The best of clays can be spoiled by the personnel in the plant, so much so that for practical purposes the chemical constituents are in many cases of secondary importance as compared with the human element in the manufacture of brick.

The manufacturers change the "mix" in making different brick to meet the various services encountered. The fine or coarsely ground clays make a dense or open textured brick. Less spalling is encountered with an open textured brick. A dense brick, however, will resist the slagging action of fuels. In other words, from the contractor's point of view, the physical structure of the brick is of far more importance to the life of the furnace than is the chemical composition.

Fire brick burned in a tunnel kiln are more uniform and more thoroughly burned than is possible in a beehive or other type of periodic kiln. Tunnel kiln brick are free from kiln marks, that is, marks made in the side of the brick owing to the weight of other brick, as is the case when the brick are piled in large quantities and to greater heights in the periodic kilns.

The color of the brick is no indication as to the quantity of iron in the brick. The color can be controlled from an almost pure white to a mottled or brown color simply by increasing or decreasing the amount of air used for combustion when burning the brick.

Regardless of how much care is taken in the manufacture of brick, the success or failure of the brick is dependent upon how it is installed in the furnace; just as no matter how much care is used in the manufacture of steel to obtain a uniform chemical analysis and in the rolling of the steel, its service and use is in a very large measure dependent upon the skill and ability of the forger and heat treater.
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Blast Furnace-Steel Plant

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Keystone Lubricating Co.

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Sintering Furnaces.

Sintering Furnaces.

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Soaking Pit Furnaces.
Surface Combustion Corp.

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Steel Plate Construction—Heavy.
Blaw-Knox Co.

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They take the GUESSWORK out of Converter Blowing

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This 12" and 30” x 50” cold mill was built by Mackintosh-Hemphill Company, Pittsburgh, and is installed in the plant of the Allegheny Steel Company, Brackenridge, Pa.

It comprises 4, four-high stands, each equipped with 4 Timken Bearings, 2 on the top back-up roll and 2 on the bottom back-up roll. Dimensions of bearings, 16.9375” bore x 26½” O.D. x 13” wide.

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for use with Hand-operated Bin Gates

A modern stockhouse car including every feature necessary for successful operation with lowest maintenance.

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BLISS CLUSTER MILLS
ROLLER-BEARING EQUIPPED

These mills are built in capacities ranging from 4" to 72" wide for hot or cold rolling.
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The Continuous Heating Furnaces and Mechanical Equipment for 2 High Mills included in this System are covered by one or more of the following patents: Nos. 1,702,739, 1,730,739, 1,746,488, 1,750,534, 1,760,762, 1,767,574 and 1,779,964.

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Warren, Ohio

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25 YEARS

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UNITED Roll Lathes as shown are now in operation on all sizes of rolls, for many kinds of mills.

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- Enclosed Headstocks
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- Liberal Weight

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More than 107,000 miles of wire form the four great cables. Each cable is made up of 26,474 wires divided into strands of 434 wires each.

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Automatically opens furnace door and delivers sheet or pack from inside furnace to mill or mill feeding table. Automatically centers sheets, on double row furnaces, with center line of mill. Sheets delivered to mill at furnace temperature . . .

In Combination with

McCANN WALKING BEAM FURNACES

and modern automatic handling equipment through the mill, maximum production of high grade sheets at an extremely low cost is assured.

All auxiliary equipment for full or semi automatic operation is available.
A TRULY accurate pyrometer must first detect and then record very small changes in temperature. Micromax, the improved L & N Potentiometer Pyrometer, offers micrometer sensitivity—the highest sensitivity available in an industrial potentiometer. A temperature change so small as to cause the galvanometer pointer to move only 1/1000th of an inch is detected and recorded. Further, the Micromax balancing unit is not affected by wear. It requires no adjustment.

Climaxing more than 20 years of specialization in potentiometer pyrometers for industry, Micromax introduces a new order of accuracy and reliability in industrial pyrometers.

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE
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Above: Closeup of Micromax balancing unit, showing galvanometer pointer A, and feeler levers B and C. Temperature at thermocouple is constant, therefore circuit is balanced and pointer at center. 

Send for your copy of new Catalog No. V-87

The circuit is standardized automatically, at least every 45 minutes, in the L & N Micromax Recorder

Temperature at thermocouple is still constant. Feelers have closed on pointer, finding it in balanced position. Temperature record remains constant. If the pointer moves only 1/1000th of an inch, the feelers will detect this change.

Temperature has changed. Feelers have closed on pointer, finding it in unbalanced position. The arm of a non-slip clutch at once takes a new position, causing the recorder pen to step quickly to a corresponding place on the chart.
OLD STYLE SHEET MILLS CAN BE

THE AETNA-STANDARD

COMBINATION METHOD

OF SHEET AND TIN PLATE ROLLING.

A COMBINATION OF MECHANICAL FEEDER AND CATCHER ALONG WITH AN AUTOMATIC DOUBLER, SUITABLE CONVEYORS AND A CONTINUOUS HEATING FURNACE, OPERATING IN CONJUNCTION WITH A STANDARD SHEET ROLLING MILL.

The old style Sheet Mill, like the one shown at the right, can now be re-vamped and modernized to the point where it will produce sheets that will meet the demands of today's close, competitive, market.

This style of mill - a type that has been in use for almost a century - if used under the AETNA-STANDARD COMBINATION METHOD will still retain its great flexibility of operation on either large or small orders - at a substantial reduction in operating costs that will enable it to take its place on a very favorable competitive basis with the more recent types of Sheet Mill.

The Steele patent, covering the manufacture of Sheets by the method, as described above, and the license to operate in such manner, is controlled by the AETNA-STANDARD Engineering Company, sole licensee under U.S. Letters Patent issued to L. C. Steele.
SAVED — BY THE USE OF —

LETS SAVE THESE MILLS

THIS METHOD of Sheet and Tin Plate Rolling, as designed and built by AETNA - STANDARD, utilizes your present Sheet Mill and requires but a comparatively small investment to bring it in line with today’s production methods.

There are hundreds of these mills in the Sheet and Tin Plants of the United States - AND - they can be saved.

Our business is designing and building machines for rolling and finishing steel.

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*Reduces:* Fuel Consumption, Repairs, and Costs.

*Replaces:* Reversing Valves and Stacks.

Complete in itself, including the most recent developments in practical furnace operation.

Note the simplicity and write for particulars.

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Worcester, Mass., U. S. A.
BRISTOL Presents to Industry
a Full Floating Recorder Controller

Use of a Free Vane, floating between twin air jets, gives temperature control without distortion

EMPLOYING a unique and revolutionary principle of operation, this new BRISTOL Free Vane Recorder Controller marks an almost incredible advance in air-operated automatic control. It makes possible regulating the temperatures of industrial processes to a degree heretofore unobtainable.

Controller action is full floating. Under the influence of temperature fluctuations the ingenious Free Vane device utilized for effecting control actually floats from one position to another. It does no mechanical work. It experiences no resistance or friction. Nor does it interfere in any way with the motion of the recording element to which it is attached. Temperature indications are accurate. They disclose faithfully the state of the process under control. There is no distortion or restraint, either at, above, or below the control temperature.

The Free Vane Recorder Controller gives precisely the control which the temperature record indicates. It incorporates BRISTOL'S perfected sensitive actuating element of the popular helical tube type which has been so widely accepted by industry as the standard of accuracy.

A 24-page catalogue has been prepared that describes this remarkable new Free Vane Recorder Controller. It should be in the files of every industrial engineer and executive. Just fill in the coupon and write for your copy.

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For use on telescopic coal loading chutes of car dumpers with or without Doyle type or similar trimmers.

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"The moving finger writes and having writ, moves on."
"The new way gives place to the newer way."
"The future is ever present."
"Progress is a tyrant."

MICHIANA PRODUCTS CORPORATION
MICHIGAN CITY, INDIANA
ROLLS

“MESTA Special” Alloy Steel Rolls
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MESTA MACHINE COMPANY
Pittsburgh, Penna., U. S. A.
The pressure type of Theisen Disintegrator eliminates the need of a booster fan by incorporating the booster element into the disintegrator proper, thereby eliminating the pressure losses and operating and investment costs incurred in the inter-connecting piping, valves and booster fan. This Disintegrator will deliver fine cleaned gas at pressures up to 20 in. of water.

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Let us tell you more about Theisen Disintegrator Gas Washers. A descriptive booklet will be sent at your request.
S. S. Stove Checker System for Hot Blast Stoves

Secures Superior Performance Because this Construction Has:

- Structurally the strongest possible design from the masonry standpoint.
- Uses less gas per blast unit than any other type of stove.
- Gives remarkably small drop in wind temperature over blast period.
- Maximum wall thickness in high temperature zone, giving structural strength to withstand high temperatures.
- Maximum heating surface in low temperature zone to sustain high heat transfer rate.
- Horizontal passages through each tier of brick equalize pressure and velocity through vertical passages.
- Circular openings in checker brick present path of least resistance for gas or air passing through stove; therefore minimum draft loss and resistance to air flow.

An illustrated booklet has been prepared describing the S. S. Stove Checker System. Write for it.

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310 SOUTH MICHIGAN AVENUE—CHICAGO U.S.A.
You Pay the Small Cost of STIC-TITE no matter what insulation you buy,

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Morgan Welded Crane

Morgan 10 Ton 58'-3" Span All-Welded Crane

Girders are made up of girder beam sections with welded stiffeners. Auxiliary girders are provided on each side for lateral strength.

10-Ton Worm Type All-Welded Trolley

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Morgan Cranes are manufactured for all capacities, for any required span, with one or more hoists, and can be furnished with plain or roller bearings, with worm or spur-gear trolleys, to meet the requirements of the purchaser. Our engineers will gladly assist in solving your crane problems.

Write for Bulletin No. 31
CARBOFRAX gives to industry pyrometer protection tubes of ideal characteristics. With "Carbofrax" tubes you literally increase the sensitivity of the instrument. Because "Carbofrax" has such a high thermal conductivity—ten times that of fire clay. Because "Carbofrax" tubes can be made with extremely thin walls—thus again aiding in the rapid, uniform transmission of heat to the couple and minimizing temperature lag in reading. For these reasons they should be used whenever a secondary refractory protection tube is required. These tubes show far greater strength at high temperatures. They have the ability to withstand severe temperature changes without spalling or cracking—show no tendency to soften or distort in service. So why smother your delicate pyrometers with ordinary protection tubes. Carried in stock in fourteen standard sizes, with and without collar—send for more complete data.

THE CARBORUNDUM COMPANY

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Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle • Denver Fireclay Co., El Paso, Texas
Harrison & Company, Salt Lake City, Utah • Williams & Wilson, Ltd., Montreal-Toronto, Canada

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Plants and warehouses in all industrial centers make Linde Oxygen, in the familiar grey and green cylinders, available everywhere at minimum transportation cost. Users also benefit from the unique engineering facilities of Linde Process Service.

Prest-O-Lite Acetylene
Prest-O-Lite Dissolved Acetylene . . . the standard for well over a quarter of a century . . . is available from a Prest-O-Lite plant or warehouse near you. Prest-O-Lite is portable, convenient, economical.

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Suitable Oxweld blowpipes, regulators, welding rods and supplies are available for every operation. Complete stocks and service stations are located in all principal cities. Oxweld low-pressure injector type blowpipes, High Test welding rods and other supplies represent maximum values in oxy-acetylene welding and cutting equipment.

Union Carbide
Careful expansion of distributing facilities has made Union Carbide available to every American industry from over 250 warehouse stocks. Sold always in the Blue and Grey drum, it has been the accepted standard for uniform high quality for more than 30 years.

Oxwelding—a source of important operating economies

WORN or broken equipment parts, restored to usefulness by the oxy-acetylene process, may save you hundreds of dollars annually in replacement charges.

Oxwelding makes reclaimed parts as serviceable as new ones. Frequently—by reinforcing weak places or by re-surfacing the worn places with wear-resisting alloys—they are made better than new.

Equipment for oxwelding is inexpensive and easy to use. Savings on a single job often pay for a complete welding and cutting unit.

Numerous uses for oxwelding and cutting, and the extreme portability of the equipment, warrant your immediate investigation of the possibilities of this process as a means of reducing maintenance costs.
Another important advantage of "Lubrotite" Gate Valves is the elimination of sticking... which is prevented by screwing down the lubricating guns a turn or two as the valve is being closed.

Also, a turn of the guns will free a valve which has become stuck after being closed for a long time.

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HERETOFORE... valve maintenance has been a troublesome and expensive problem. Deposits, scratches, scores and corrosion have oftentimes caused perfect valves to leak. Repair or replacement was then necessary.

NOW... in the new Reading-Pratt & Cady Lubrotite Gate Valves, a thin film of lubricant is fed to the seating surfaces. This film protects the seats and the valve stays tight so long as the melting point of the lubricant-seal is not exceeded.

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The heat-resistant alloy steels used in Surface Combustion continuous furnaces conform to the most rigid specifications—subjected to unusual laboratory tests that reveal the slightest flaws and imperfections. For years Surface Combustion’s staff of metallurgists—specialists in alloys—has studied, compiled and collected information. Working closely with alloy manufacturers Surface Combustion specialists have removed the uncertainties imposed by imperfect alloys . . . and have developed special heat-resistant steels that stand up under the severe stress of modern continuous methods. This is Industry’s assurance against costly mechanical failure in the field.

Photomicrographs of two alloys are shown. The microstructure ABOVE is broken down from severe laboratory tests to which it was subjected in SC laboratories. The alloy BELOW survived this series of rigid tests.
1. General laboratory set-up of tensile machine, heating unit, and control apparatus where pull tests are made on alloy steel bars previously held at high temperatures for several hundred hours.

2. Close-up view of heating unit where test bars of alloy are pulled at elevated temperatures.

3. Tube furnace and control set-up used for long time tests to determine the effect of elevated temperatures on the alloy.

Operated by Henry L. Doherty & Company

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Surface Combustion Corporation
Toledo, Ohio.

Sales and Engineering Service in Principal Cities
Armstrong-insulated lehrs cut heat waste for Illinois Glass...

In September, 1925, Amsler-Morton installed these 14-foot, Type B lehrs in the Bridgeton, N. J., plant of the Illinois Glass Company, now known as Owens-Illinois Glass Company. They were thoroughly insulated with Nonpareil Insulating Brick, made by Armstrong.

From the beginning, these lehrs have consumed less fuel to do a given job—thanks to the insulation. Today they are still saving money for the Owens-Illinois Glass Company. For Armstrong's and Nonpareil Insulating Brick put every useful B.t.u. to work. Surveys in many plants show actual fuel savings up to 40% resulting from the use of this efficient insulation.

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Armstrong's Insulating Brick are burned at more than 2500° F. They serve efficiently under temperatures as high as 2500° F. behind the refractory, without warping or fusing. Nonpareil are safely used up to 1600° F. Both are light and have ample strength for any type of construction. They are furnished in all standard firebrick sizes, and in special shapes to order.

Armstrong engineers will gladly help you plan savings in your own plant with these brick. Samples of each sent on request. Armstrong Cork & Insulation Company, 941 Concord Street, Lancaster, Pennsylvania.

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Open Hearth Control

CUTS COSTS OF STEEL PRODUCTION

Wide awake engineers realize the vital part which control and metering equipment play in cutting production costs of iron and steel. They realize, too, the value of selecting equipment which will best fit their needs and do its task thoroughly.

Designed to meet the specific requirements of each installation, Bailey Open Hearth Furnace Control is complete in every detail. Based upon accurate and reliable metering equipment it provides adequate records of furnace operation. Furnace draft and the air supplied for combustion are automatically controlled for best results.

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In the interest of lower production costs, it will pay you to learn more about Bailey Open Hearth Furnace Control. Write today for information.
If you are accustomed to fixing the depreciation charge of your new equipment on a definite basis, you will be more than pleased to know that with Porter Locomotives you can figure depreciation on the basis of lifetime service.

In fact, hundreds of service records, ranging from 20 to 50 years, prove that Porters depreciate much slower than the average industrial haulage equipment.

The Porter Line consists of standard Steam, Gas-Electric, Oil-Electric and Fireless Locomotives—each one built to give the most service and economy in the field for which it is particularly adaptable.

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A STRUCTURAL MILL DRIVE...

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Reduction drives for sheet, bar, strip, plate or structural mills have been built by G&F for many of the country's largest steel plants. The experience thus gained by G & F, plus complete production facilities expertly manned, insures the buyer of a soundly engineered and sturdily constructed reduction drive when he buys from G&F.

A corps of G & F engineers are always available for consultation on your reduction drive problems.

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THE Type B Pulverizer is efficient and quiet—because the grinding zone is so simple. It is a modern means for pulverizing coal that gives the sustained high capacity and uniform fineness so necessary with pulverized-coal firing.

Coal is pulverized by two rows of balls, rolling and grinding between a rotating ring and two stationary rings. The grinding pressure—applied by externally adjusted springs—can be regulated so that coals of different grindability can be pulverized to suit your operating conditions.

For further information about this pulverizer write for a copy of Bulletin No. 5-80. Address, Fuller Lehigh Company, 85 Liberty Street, New York, N. Y.

A few of the many plants in which Type B Pulverizers are operating

- OHIO EDISON COMPANY
  - Toronto Station
- DOW CHEMICAL COMPANY
  - Midland, Mich.
- BROAD RIVER POWER COMPANY
  - Parr Shoals Station
- WAUKEGAN GENERATING COMPANY
  - Waukegan Station
- NORTHERN INDIANA PUBLIC SERVICE COMPANY
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PULVERIZED-COAL EQUIPMENT
WATER-COOLED FURNACE WALLS
Framed and Insulated
to stand the toughest service
your mill can offer

TYPE MD—the steel-mill engineers' motor
—has a frame of cast steel as strong, as
powerful, and as enduring as the mightiest
mills on which it is installed. And to
facilitate examination of coils, commutator,
and other parts, the upper half-cover is
hinged on all sizes up to and including the
75 hp; all larger sizes have a split and
removable cover.

Field coils of the Type MD are formed
with class “B” insulation throughout, with
asbestos-insulated strip for the larger sizes
and “Deltabeston” covered wire for the
smaller. On compound and shunt-wound
motors, the shunt windings also have
class “B” insulation. Coils are vacuum-
impregnated with insulating varnish. Coil
terminals are both riveted and brazed to
strip windings.

Assembly reflects G-E motor-building care.
Main poles are laminated and riveted to­gether. Interpoles are solid steel plates.
Steel spring guards hold coil tightly against
magnet frame, and form guide for polepiece
when it is inserted in the coil. Thus coil
can be made a very tight fit without danger
of damaging when pole is inserted.

The Type MD is designed to meet the standardized
dimensions and rating specifications of the A. I. &
S. E. E.
When we say that Fast's Self-Aligning Coupling is free from grit, dust, flying abrasives and moisture, we don't mean that it is free for a month, six months or a year.

We mean that these machinery-wearing materials can never get in. When we say "permanent," we mean "permanent." Fast's couplings last!

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Years of service have proved that Fast's Couplings "last as long as the connected machines."

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When this oil fired steel furnace was insulated with Carey Alumino Hi-Temp Blocks, the fuel saved paid for the insulation in ten days. The roof of the furnace was covered with two layers of Alumino Hi-Temp Block making a total thickness of 5 inches, and Carey A-1 Asbestos Cement was applied on the sides.

The thermal conductivity of Alumino Hi-Temp Block is about one-half that of ordinary insulating brick, and it is therefore rapidly replacing less efficient materials in furnaces, lehrs, kilns, regenerator chambers, calcining tunnels and other equipment in which the internal temperature reaches 3000°F. Furthermore, actual tests have proven that its high insulating efficiency does not tend to shorten the life of the brick lining over which it is applied.

Samples, prices and definite evidence of the superiority of Alumino Hi-Temp will be mailed promptly upon receipt of your inquiry.

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Why Silico-Manganese Alloys
Deoxidize Open Hearth Steel Faster and Better

When silicon and manganese are added to steel in basic or acid furnaces as a combination alloy, they deoxidize the bath faster and better than when added individually. The manganese silicate formed by their reaction with iron oxide is enormous in size as compared with the original iron oxide, and it rises with greater rapidity.

Silicon and manganese may be introduced either as Silico-Spiegel or as Silico-Manganese.

Electromet Silico-Spiegel is an electric furnace product made under the supervision of experts. It contains 7 to 8 per cent. silicon, 25 to 30 per cent. manganese, and less than 4 per cent. carbon.

To open hearth operators who prefer a more concentrated alloy, Electromet also offers Silico-Manganese containing 12 to 14 per cent. silicon, 65 to 70 per cent. manganese, and less than 3 per cent. carbon. Since this alloy produces a quicker reaction than Silico-Spiegel, the temperature of the metal is not lowered to the same extent. Also, smaller amounts can be used.

The speed and economy that Electromet Silico-Manganese alloys introduce into open hearth practice make them the ideal deoxidizing materials in your plant.

Electromet Metallurgical Engineers will be glad to furnish any further information you require.

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Unit of Union Carbide and Carbon Corporation

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It is not unusual for a Mantle Recuperator to effect a 40% fuel saving... which means that recuperation quickly pays for itself. The magnitude of the saving is purely a function of air preheat at the burners and the temperature of the waste gases leaving the furnace. Industry has fully recognized the value of metallic recuperation... profitably applied to almost all types of industrial furnaces. Mantle engineers can tell you how much recuperation will save on your furnaces!

Write for the new MANTLE RECUPERATOR CATALOG and data book. You will be interested in the valuable, exclusive information it contains.

OPERATED BY HENRY L. DOHERTY & COMPANY

Surface Combustion

SURFACE COMBUSTION CORPORATION
TOLEDO, OHIO.

SALES AND ENGINEERING SERVICE
IN PRINCIPAL CITIES
WOULD 40% FUEL SAVING INTEREST YOU??

Ljungstrom Preheaters now in service are making daily savings of this magnitude. Installations with stack gas entering at 1800 deg. fahr. are delivering air at 1000 deg. — and this performance can be duplicated on any furnace.

EXTREMELY high heat recovery at high commercial profit is possible only with the Ljungstrom continuous regenerative counterflow principle and Ljungstrom quick-acting heating surface.

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Give us operating data on your billet-heating furnaces, melting furnaces, or reverberatory furnaces of any type and without charge we will submit cost and performance figures, together with positive guarantees and references to highly profitable installations.

Over 800,000 boiler hp. of Ljungstrom Air Preheaters in service in the U.S.A.

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The Ljungstrom Horizontal Air Preheater. Obtainable also with integral forced-draft and induced-draft fans

Exclusive advantages of the LJUNGSTROM AIR PREHEATER
A truly continuous regenerative heater. No reversing valves required.
Special nickel-chrome alloy steel for resistance to extreme heat
Smallest volume, weight and size for very high heat recovery
Quickest heat transfer of any commercial recovery equipment
Straight-line and uninterrupted air and gas flow
No dead circulation pockets
Uniform heating. No cool and hot strata in air delivery
Cleaned without service interruption, opening or hand brushing
Element reversal doubles life of heating surface
Cost of complete heating surface renewal does not exceed 15% of preheater cost
Maintenance negligible in comparison with that of a refractory regenerator for cleaning, and (5) special nickel-chrome alloy steel to resist extreme heat.

Give us operating data on your billet-heating furnaces, melting furnaces, or reverberatory furnaces of any type and without charge we will submit cost and performance figures, together with positive guarantees and references to highly profitable installations.

Over 800,000 boiler hp. of Ljungstrom Air Preheaters in service in the U.S.A.

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BLAST FURNACE AND STEEL PLANT Has twice as much paid circulation in steel plants as any other publication.
THE TIME TO DIG Clams
IS WHEN THE Tide is Out

When business is rushing, even old ideas pay dividends.

But when times are dull, a new idea for improving your product, for cutting production costs, or for developing new markets may mean the difference between red and black on the balance sheet.

Hundreds of such ideas will be waiting for you when the 1931 Convention of The International Acetylene Association opens in Chicago on November 11.

If you are there, you will hear the tested ideas of production men, research engineers, sales experts, and designers from every important branch of the welding industry.

You will get angles and viewpoints obtainable in no other way. And when you leave Chicago on November 13, you will have a headful of practical operating ideas worth a dozen times the cost of the trip. Everyone is welcome.

Here are some of the subjects you will hear up-to-the-minute discussions on:

- Business Prospects for 1933
- Welding and Its Future
- Revised A.S.M.E. Boiler Code
- Training Welders
- Testing Welds
- Aircraft Welding
- Railroad Welding
- Marine Welding
- Automobile Welding
- Welded Piping Design
- Pipe Line Welding
- Welding the New Alloys
- Painting, Enameling and Lacquering Welded Joints
- Engineering Education in Welding
- Industrial Acceptance of Welding

Motion pictures and slides will be used to illustrate many of these discussions.

32nd Annual Convention
Congress Hotel
Chicago
Nov. 11 · 12 · 13 · 1931

INTERNATIONAL ACETYLENE ASSOCIATION
ESTABLISHED 1898
30 EAST 42nd STREET, NEW YORK
INCREASED PLANT EFFICIENCY

IS ESSENTIAL TO PROFITS

In fair weather days business may look for profit margins in increased volume of sales—in markets which are constantly expanding beyond the point on which sales and production quotas were based.

But when markets contract and volume is sharply cut—when even the promise of growing volume is offset by serious price declines—profit is something which must be definitely planned and not left to come automatically with increasing output.

Until prices are stabilized operation at a profit will be a goal which at the best will be difficult of accomplishment.

One of the first essentials for reaching that goal lies within the plant—in increased operating efficiency.

Cutting costs in plant operation, through alteration and modernization of existing equipment or installation of new, is a task for which this company is particularly equipped. May we offer you our suggestions?

McKee Experience in Steel

For twenty-five years this organization has been designing and building complete blast furnaces and accessories. Successful installations are located in all the important steel producing districts in America and foreign countries.

Departments for the design and construction of Open Hearth Furnaces, Bessemer Converters and Soaking Pits have been added to extend the field of operations from Ore to Blooming Mill. Complete layouts for individual units are handled on a single contract, with undivided responsibility.

Over a dozen McKee-designed accessories are widely employed for economizing space and cutting production costs.

We are prepared to make reports on plant operation, fuel surveys, or in fact investigations of any problems in the iron and steel industry, with a special view toward more economical operation.

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Published the first of each month by Steel Publications Incorporated
Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.

DON N. WATKINS, President
D. S. WATKINS, Vice President
M. M. ZEDER, Secy.-Treas.

EASTERN OFFICE
STEEL PUBLICATIONS INC.
29 West Thirty-fourth Street
New York, N. Y.

WESTERN MANAGER
GLEN W. NEELY
525 North Grove Avenue
Oak Park, Ill.

Subscription Price:— In the United States, $2 per year; Canada, $3.00; all foreign countries, 15 shillings. Single Copy 25 cents.
Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.
When Koppers plants supplement or partially replace existing equipment, they bring new vigor to the entire coke and gas producing structure. Whether the addition consists of Becker Ovens, By-product apparatus, or a material handling plant, its relation to the customer's equipment and business is carefully worked out in terms of current operating and sales practice.

The result is a unified, revitalized plant that makes new records in production and efficiency.

Our engineers will be glad to help you consider the application of Koppers plants to your coke and gas requirements.
Diversity of Product

There has recently appeared in technical magazines a notice to the effect that a well known manufacturer of steel will soon place on the market a razor blade. To the cursory reader this statement will be of interest only in that it holds out possibilities for making less arduous the daily morning routine; but to the man in the steel industry, its significance lies in the fact that this particular manufacturer has found a new form in which to market his steel.

He has secured a greater diversity of product.

There is always some doubt attending the marketing of a new product, and it therefore requires courage, especially at a time of low demand. In this day when the general policy of the industry is defensive rather than offensive this manufacturer casts aside the policy of inaction and boldly seeks to increase his output by entering a new field. In this field he will compete with foreign steels for at present these steels are used exclusively in the manufacture of the blades now on the market.

The spirit that will open up new outlets for our steel products is not one of passiveness. Today the prevalent attitude is one of "watchful waiting" and although this connotes alertness, it does not imply aggressiveness. So long as this attitude is general in industry so long will it remain in the doldrums. We all get somewhat of a thrill when we see some individual or organization step out from the crowd and by ignoring precedent and tradition achieve some worthwhile objective.
An Institution within an Institution

We sometimes delineate our roll division as An Institution within an Institution, and do so—feeling it profitable that the prospective purchaser knows of the close affiliation a Birdsboro roll product holds with the technical atmosphere under which it operates.

Birdsboro rolls are cast and machined within an industrial city—midst the designing and building of the very mills in which they function... To equip your stands with Birdsboro rolls—means a betterment in monthly tonnage.

We've an interesting booklet for the man unfamiliar with our product.

BIRDSBORO
STEEL FOUNDRY AND MACHINE COMPANY
DESIGNERS AND BUILDERS
BIRDSBORO, PENNSYLVANIA
Rationale of a Dry Blast in Iron Smelting

By WM. McCONNACHIE

It is on record that in some cases where a dry blast has been used only 80 per cent of the fuel used with an ordinary blast has been required. From all that can be learned from the physicists as to heat and combustion the only fuel economy which can absolutely be counted upon is that represented by the heat absorbed in the decomposition of the water vapor present in the ordinary hot blast, and as this amount is comparatively small, such a measure of economy must be considered as anomalous.

So far as the writer is aware, the only hypothesis hitherto advanced to account for it is that of Jas. E. Johnson, Jr., who tells us that he advanced it because he felt, as presumably all real students of iron making have felt, that the explanations of Ledebur and Bell as to the marvelous economies effected by using a hot blast are far from satisfactory.

While Johnson's theory is widely accepted, and is countenanced by such eminent metallurgists as Profs. Howe and Richards, it would seem to have been advanced without any great consideration of the subject. It is based on the supposition that the higher the temperature of combustion the greater will be the smelting power of the furnace, as there will be a greater "head" of temperature, and in consequence a more rapid transfer of heat to the materials.

His calculations need not be taken very seriously, as when calculating the theoretical temperature of combustion he takes no account of the fact that part of the oxygen of the blast is taken up by other substances as well as by carbon, and that all the carbon dioxide gas formed is not instantaneously reduced to CO, as a portion becomes fixed in combining with alkalies.

Unit weight of oxygen in combining with iron gives a much larger amount of heat than when combined with carbon to form CO, and this, with the other factors mentioned, will affect the temperature produced by the combustion.

Further, in calculating the available head of temperature, he assumes that the descending materials in the furnace are preheated only to the "critical" temperature, while some material may melt at a relatively high level and run through the heating zone too fast to acquire a very high temperature; the coke, and such materials as do not fuse easily, such as lime not in intimate contact with silica, or silica not in intimate contact with any basic substance, will be more highly preheated. There is thus no serious variation in the difference in temperature between the preheated materials and the products of combustion no matter to what temperature the blast is heated, and the rate of heat transfer will in consequence not be greatly different even
when the true temperature of combustion is considerably higher, as it is of course when a dry blast is used.

In general support of his hypothesis, some official figures as to the fuel used in Clyde Iron Works in 1829, 1830 and 1883 are quoted by Johnson. The figures are evidently those supplied by the owner to Prof. Clark who put them in an appendix to his paper titled "Hot Blast" presented before the Royal Society of Edinburgh in 1835.

It is made perfectly clear in Prof. Clark's paper that the fuel used with a cold blast in 1829, and with a warm blast in 1830 was coke, the amount being 45 per cent of the weight of coal described as used in making a ton of cast iron, but, although Johnson is dealing with the thermal and not the commercial side of the subject, he omits to mention the fact that the coal was converted to coke before use in the furnace, with considerable loss in the process.

Examined in this way his hypothesis is seen to be of no value and the writer has worked on it only because he feels strongly that its too ready acceptance and approval by eminent men, and the stopping of further inquiry has very possibly prevented real progress.

As already stated, it is on record that with the same materials in a particular furnace, 80 per cent of the fuel was found to be sufficient when the blast was dried. As the drying of the blast only reduces the quantity of work required of the furnace by a very small amount, that is, the usual work of reducing and melting the metal and slag produced, and as there is no change in the method of applying the smaller amount of heat supplied with and produced by the action of a dry blast, it is evident, since the work is done—and done at a faster rate—that there must have been some alteration in the conditions which control or affect the chemical reactions in the furnace. And as the said chemical work, that of removing the oxygen and other substances found in pig iron, is done in the part of the furnace above the spaces in which true combustion occurs, we know where to look for proof.

There are four separate agents at work, each removing oxygen from the materials. As each has its own characteristics, a brief review is necessary.

**Hydrogen**

Hydrogen, less in amount when the blast is partly dried, is derived when the carbon in the fuel takes up the oxygen in the water vapor. The research experiments of Sir Isaac Lowthian Bell show very conclusively that hydrogen by itself is a more powerful reducing agent than the carbon monoxide produced simultaneously and in much greater amount by the action of the blast on the fuel. Further, Bell has demonstrated that even when present in considerable quantity, as when raw bituminous coal is used, hydrogen does not remove much of the oxygen from the ore in the furnace.

The only possible explanation which puts such apparently contradictory facts into agreement, is that in the furnace, something prevents the hydrogen from acting on the oxides.

Drying the blast reduces the amount of hydrogen present, and as this is known to be comparatively ineffective, it may be dismissed as not of any great importance in the inquiry.

**The Cyanides**

The alkaline cyanides, although known to have most powerful reducing properties and also known to be present in considerable quantities in the furnace, have for the most part been consistently ignored in all work dealing with the removal of oxygen from the ore. Although of the greatest importance in iron making, and considered to be so by Roberts-Austen and, in earlier days, by Bunsen and Playfair, (who discovered them in a Derbyshire furnace), it is only recently that any rational idea of how and where they are formed and what controls their presence and quantity could be obtained.

However, we now know (see “Blast Furnace and Steel Plant,” September 1930) that they are formed below the tuyere level in quantities depending chiefly on the “liminess” of the slag—not on just “basicity”—and on the nature of the materials with which the ascending alkali meets, and the power of such materials to combine with and so ensure the return of the alkali to the “well.” The greater the power of interception, the more alkali will be returned and the more cyanide produced continuously so long as the slag is kept “limy” and the temperature is over a white heat. As they rise with the other gases between the tuyeres and next the wall, they escape destruction by the blast, and so are effective in removing a considerable amount of oxygen from the ore.

Their formation and operation cannot be considered as likely to be affected by the higher temperature of the lower part of the furnace or the lower temperature of the upper part (which difference in temperature can be observed when a dried blast is used) or by the relative humidity of the blast.

**Solid Carbon**

Although the volume occupied by the coke is much less in proportion to that of the ore when a dry blast is used, as there is no change in the method of charging, there will be no greater number of points of contact between the carbon of the fuel and the oxides in the ore.

The reduction of iron oxide by solid carbon requires a relatively high temperature, and is endothermic, taking place at a comparatively low level in the furnace, so it cannot be supposed that the smaller amount of heat developed with a dry blast can in any way favor the actual removal of oxygen by solid carbon. There is nevertheless a large amount of oxygen removed by direct action of solid carbon, which, however, is derived from the fourth and last of the reducing agents at work in the furnace in the upper levels.

The action of carbon monoxide is peculiar. As
soon as it has removed some of the oxygen from the ore in contact with it, it begins to deposit carbon on the partly reduced oxide, thereby covering it with a protective coating of carbon which prevents further intimate contact between the reducing gases and the ore which has been attacked.

There is no evidence that the Fe₂O₃ of the ore has the catalytic power shown by freshly formed lower oxides of iron, so this carbon coating does not prevent the removal of part of the oxygen in the sesquioxide, and in this way we get to understand why, even when present in large quantity, hydrogen has so little effect, as the reduction of the Fe₂O₃ to Fe₃O₄—possibly even to FeO—will be done by the hydrogen and carbon monoxide in proportion to their respective quantities, and, although we cannot get such proof as would be desired, we see that the hydrogen and carbon monoxide may only reduce the Fe₂O₃ to a lower oxide, as intimate contact is prevented by the carbon coating.

This deposition of carbon is accompanied by the formation of CO₂, the catalyst inducing the reaction 2CO = C + CO₂, but unfortunately, since we cannot tell how much of the CO₂ in the exit gases may have come from the limestone used, or the direct action of CO on the peroxide of the ore, this gives us no clue as to the amount of carbon so deposited in any given case.

By various experiments, as recorded in his “Principles of the Manufacture of Iron and Steel,” Sir I. Lowthian Bell demonstrated that the catalytic effect of the partly reduced ore varied greatly according to the ore, and that the deposition of carbon from CO was influenced by the velocity and the temperature of the reducing gas.

Taking those influences in detail, we find we may ignore the possible effect of velocity, as, while higher velocity implies a greater impact with the solids in the path of the gas current, and a greater impact produces better and closer contact (which favors rapid chemical reaction) since, when using a dried blast under favorable conditions the rate of combustion is much the same, the velocity of the gas will also be much the same as with ordinary blast.

Further, since the ores are not changed, the catalytic effect of the oxides will be the same, so there remains only the effect of a possible difference in temperature to consider in explanation of the great economy in fuel reported, as, for instance, in the case used by Richards as data for some valuable calculations (Metallurgical Calculations, Part II. Problems 57 and 58.)

For the reasons already given, it is considered that only a fraction of the oxygen of this ore can be removed by the direct action of hydrogen or carbon monoxide.

If the circumstances are favorable, a quantity of carbon may be thrown on—or in—the ore, sufficient to remove a further fraction of the oxygen, the necessary amount depending on the quantity of cyanides which the particular conditions render available to complete the reduction of the ore before fusion. If unfavorable when the temperature is high enough, the insufficient deposited carbon is of course used up in direct reduction, and the remaining oxide has to be reduced by CO at a temperature which ensures that the CO₂ produced will be converted again to CO, either by the metallic iron or by the solid carbon of the fuel.

The carbon used up in the latter case has done no work, while the fine deposit of carbon is mostly derived from CO produced about the tuyeres and therefore has produced heat. (Of course the catalytic action of the partly reduced ore will be effective on CO no matter how produced, and it is interesting to notice, that by the catalytic action on CO produced from the action of deposited carbon on iron oxide, there is an auxiliary quantity of carbon in the furnace, the carbon accumulating exactly as the alkalies accumulate, a part being continually intercepted and returned to lower and hotter levels, there to be again gasified only to be partly intercepted and again returned in a continuous cycle.)

It seems evident then that, in normal working—anything which favors the deposition of carbon from the CO of the gas will make for economy of fuel.

Bell (“Principles,” page 189) found that such deposition commenced, as already said, as soon as reduction, and was most active at 400 deg. to 450 deg. C. At higher temperatures the rate of deposition fell off rapidly, so that with an ore which after exposure for 4½ hours below a red heat, had 64 parts of carbon with each 100 of iron present, exposed for the same time to the same gas at a bright red heat had only .3 per cent of carbon, while after an exposure of 21 hours at heats rising from red to bright red, there was only 2.3 parts of carbon deposited for each 100 parts of iron present.

Since—with a dried blast—when using only 8 per cent of the fuel required with ordinary blast, the space in which the temperature most favorable for the action of CO will be much greater in extent, and further, since there will be continuously a larger amount of the said space occupied by ore, there must be a greater amount of carbon deposition. (The temperature in the upper part of a furnace run with a dry blast is of course lower than when the ordinary hot blast is used.) While we seem to have in the foregoing an intelligible hypothesis to explain the marvelous economy of a dried blast in some conditions, we should remember that temperature is only one of the factors which affect carbon deposition, and that very different results may be obtained with different ores when the blast is dried, (or the temperature of the gas reduced by any other means).

Indeed it would seem that we may congratulate ourselves on the fact that a dry blast was first used under conditions which seem to have been most favorable, and, remembering the very varied degrees of economy obtained in different places and conditions when “hot” blast was first introduced, due caution should be observed when considering the possibilities of a dried blast, or its use in any set of circumstances not previously tested out.
THE Romine patent No. 1,751,717 contemplates a method and apparatus whereby sheet metal, strip, plates or other heavy thin gage material may be carried in and out of cars in large compact units (preferably about 10-ton units) deposited or picked up and also braced for transportation without any manual handling whatsoever.

This invention is best shown in Figs. 5 and 6 and the apparatus and method used is described as follows:

In Fig. 5 is shown the method of holding and bracing these large units of flat steel. There are usually four such bundles, one at each corner of the car. Each bundle rests on wooden sills or cross members as placed transversely to the unit. The unit is held together by bracing or clamping devices which consist of “I” beams at opposite ends of the bundle and in addition, another brace preferably located midway of the bundle. The end bracing devices each comprise a pair of vertical clamping and lifting bars one at each vertical side face of the bundle. Riveted to the lower end of each bar is a stirrup which consists of a steel bar or strap riveted at the opposite ends to opposite flanges of the I-bar and bent around the lower end of it in loop form to provide a pair of openings or pockets at opposite sides. Loosely fitting into these pockets and extending transversely beneath the stack are a pair of steel bars. Each of these at its lower end is drilled to receive the ends of a turn-buckle which connects the bars of each pair. The turnbuckle has oppositely extending rods threaded at their ends to receive an adjusting nut, and by tightening these nuts the bars may be drawn together at the lower ends against the opposite sides of the bundle. The bars are connected together by means of a second turnbuckle having oppositely extending threaded rods projecting through holes in the upper ends of the bars. The bars may be adjusted toward and from the bundle by operating either the turnbuckle or the nuts on the ends of the turnbuckle rods. Each bar is provided with a vertical series of spaced holes to permit the upper turnbuckle rods to extend through any of the holes to accommodate sheets of different widths or bundles of different heights. Adjustably secured to each bar is a steel eye loop by means of which the bundle may be lifted. Each loop comprises a steel bar or strap bent upon itself to provide an eye to receive the hook of a hoisting sheave, and is adjustably secured at different heights to the bar.

From this construction it may be seen that the bars of each set may be drawn together at the upper and lower ends in order to squeeze or compress the pack transversely adjacent to each end. It may be noted that the wooden sills support the pack on the car floor without permitting the sheets to rest upon or engage the steel bars. Upon hoisting the pack by means of the eye loops, the weight of the pack will be sustained by the bars, connected together through the medium of the steel stirrups or loops. The lifting strain will be taken entirely by these parts, and none of the strain will be transmitted to the lower turnbuckle.

Each bundle, in case the metal sheets are loaded and shipped on edge, may be additionally braced at
the opposite lower ends thereof by means of suitable brace members F. (Fig. 5.)

**Longitudinal Movement Resisted**

It may be seen that any longitudinal movements of the pack as a result of collisions or shocks to which the car is subjected will be resisted by the longitudinal lower edges of the sheets biting into the bottom wooden sills, and will be cushioned by the wooden brace members F positioned against the lower opposite ends of the sheets, so that the end edges of the sheets will not become crimped.

Having described the method used in binding the pack together let us now see how this unit is moved in and out of the car. Fig. 6 illustrates a stack lifter which, when the end blocking is removed, is placed over the unit in a straddling position. The unit is then lifted bodily by means of four hoisting drums adjacent to the four corners of the lifter, and these drums operate four hoisting cables having sheaves and hooks at their lower ends (H). These hooks engage the eye hooks of the unit and thus the bundle is elevated a suitable distance above the car floor as shown in Fig. 6.

As soon as the bundle is elevated, a series of conveyor means is disposed on the floor, the same being provided with anti-friction surfaces, such as gravity rolls; these rolls are laid in alignment on the car floor so as to extend from a point beneath the bundle toward the car doorway. These rolls are in short sections and are temporarily held in place on the car floor by spikes or nails.

Adapted to travel on the conveyor or gravity rolls is a portable platform (P). Onto this platform the unit is lowered and thus conveyed out of the car onto an unloading platform.

In accordance with the method as outlined, the pack or stack may be lifted or removed from the platform either at the doorway of the car by means of an overhead crane, or may be lifted from the truck platform at any other point by the same means, depending upon the arrangement of the storage facilities of the particular plant. Thus, where the packs of sheets or material are piled in storage until ready for use at a point near that where the freight car is unloading, the stack may be lifted from the platform at the doorway of the car by means of an overhead crane and thence carried and deposited at the storage point, which is usually near the machines or presses. Where the storage point and machines are at too great a distance from the freight car to render it practical to use the overhead crane in the foregoing manner, the stack is transferred from the gravity rolls either at the car doorway, or at some point on the loading dock, to a lift truck and thence is propelled into the storage place of the plant near the machines. From this storage or delivery point, each pack is transferred to the machine by means of an overhead crane or lift truck.

**Method of Loading**

The loading of the freight car is preferably accomplished in accordance with this invention in the reverse order of steps to the manner of unloading the car, as above described. The lift truck may deliver the platform with the stack thereon to the gravity rolls. The stack is preferably first braced or clamped by means of the bracing apparatus. The platform may be rolled on the conveyor directly through the car doorway to the end of the car between the legs of the stack lifter. The bundle is then raised so as to clear the platform, and the latter moved out rearwardly from beneath the stack lifter. Thereupon the gravity-roller conveyor sections are removed from beneath the stack and the stack is lowered onto the car floor. The remaining three
stacks are successively loaded in the car in the same manner, the sections of conveyor rolls being laid each time in proper position and the stack lifter wheeled into position to straddle the stack.

Another Romine patent, No. 1,802,220, is a continuation of some of the previously described Romine patents, particularly the one last described. This patent moreover provides a method of unloading heavy unit packs of metal without breaking up the packs or without any manual handling of the separate parts under conditions where the floor of the freight car is above the ground level of the loading dock or platform.

The last described Romine patent presupposes that the car floor is flush with the unloading platform or dock, but it can readily be appreciated that in many factories or plants the railroad tracks are not depressed or submerged below the ground level so that when loading or unloading, the floor of the car is a substantial distance above the ground level. Heretofore the unloading of metal such as sheet steel under such conditions has required considerable separate and duplicate handling of the sheets. For instance, at one well known automobile plant the workmen pick up the sheets one at a time from the stack at the end of the car, carry it to the car doorway, and hand the metal sheet down to workmen stationed on the ground, who in turn pile the sheets on a suitable track or platform. It may therefore be seen that the loading of 40 tons of sheet steel from a car in such a manner requires an immense amount of labor and time aside from other disadvantages. Such a method causes great congestion, especially where the cars run directly into the plant, since an entire line of cars is necessarily tied up until the material in any one car is unloaded.

To facilitate the handling of such large units of steel under such conditions, the inventor utilizes the straddle lift unit (see Fig. 7) already described, usually in conjunction with a hand truck as shown, an adjustable portable loading or unloading dock placed just outside the car door, and an overhead crane either alone or in conjunction with an electric lift truck.

In Fig. 7 is a perspective view illustrating the manner in which a stack of metal may be loaded on the floor of a freight car and it also shows a stack or unit lifted from the car floor in position to be deposited on a conveying medium. To simplify the description of this invention we specifically describe the method of unloading, it being readily understood that the steps or methods are reversed for loading.

The metal, such as sheet steel, is packed or crated for shipment on the car floor so that the sheets or parts of the bundle or stacks will be maintained substantially intact within the bundle against shifting or displacement during transit. The metal is therefore transported in the car so that the bundles may be taken from it in units without requiring the breaking up of the bundles or stacks and separate handling in order to unload.

The metal in the present case is illustrated as sheet steel packed on the car floor with the sheets mounted on their edges, as shown in Fig. 7. The stack of sheets is, therefore, bound as a unit and held together against relative displacement of the individual sheets. In addition it is held on the wood members in order to prevent relative movement of the stack and the supporting members. The supporting members in turn form a unitary platform or pallet not directly secured or clamped to the floor of the car but allowed to float or ride longitudinally. The stack and the supporting members therefore travel or move back and forth on the car floor as a single unit or mass when the car is subjected to jolts, shocks or collisions.

For the purpose of conveying the stack of metal from the level of the car floor onto the ground or other supporting medium below the car floor level, is provided a portable loading dock or platform which is adapted to adjustment to the height of the car floor and positioned at the edge or at the doorway in order to permit the stack to be conveyed out of the car into such position as to enable it to be lifted by an overhead crane to the ground or to a lift truck platform.

The various ways of handling the sheet pack unit as it leaves the car onto the adjustable and portable dock is best shown in Fig. 8 which are self-explanatory. To guide the hand truck between the car door and platform is a ramp which comprises a pair of lengthwise extending channels which in an inverted and braced position guide the wheels of the hand truck.

Sections of roller skids can be substituted for a
The Freeze Patent—An Improved Crate

The Freeze patent claims an improved crate for the shipment of metallic sheets which will be adequate to hold not only the sheets together in bundle form during shipment, but also to permit the sealing of the sheets against the entrance of moisture. The invention is quite well adapted to foreign shipments of high grade sheets.

The construction of the crate is best understood by a description and by reference to Fig. 9, which shows a perspective view of the empty crate. The pile of sheets is first wrapped in a layer of paper. Above and below this pile, waster sheets are placed which serve not only to form a protective outer coating for the paper wrapping, but also prevent injury to the sheets beneath from mechanical causes.

As may be noted in Fig. 9, end channels 8 and 9 (whose lengths are approximately those of the sheets) are placed at each end of the pile and thus enclose the edges of the sheets at the ends. Then side channels 10 and 11 are placed in position, enclosing not only the sides of the sheets, but also the ends of the end channel members. The side channels are longer than the end channel members, and they are slit back along the edges for a distance sufficient to leave a solid portion of the channel of substantially the length of the sheet package and three lapels on either end.

The two lapels from the base of the side channels 10 and 11 are bent over to lie outside and hold in the end channels 8 and 9 and the two lapels formed from the lips of the channel are bent over to hold the first lapels. This is well illustrated in Fig. 9.

Fastening means are provided to hold the two side channels together at the ends of the crate. This means consists of a metal strap, less in width than thickness of the crate, which extends across the end and is bent around and turned under the lapels.

For additional safety, ordinary straps 17 may be placed around the width of the crate in several places as shown, and fastened with the ordinary crimped fasteners.

After the crate has been assembled as indicated, it may be sealed by the application of hot tar about the edges of the channels and about the ends of the crate. Thus, practically an air and water tight package is formed, which is adequate to protect the sheets from most corrosive influences.

Distribution of Sales, 1929, of the Manufacturing Plants in the Blast Furnace Industry

In 1929 the total value of products made by manufacturing plants in the blast furnace industry amounted to $771,425,000. Only 25.7 per cent ($198,254,000) of this production was sold; the remaining 74.3 per cent (573,171,000) being transferred to other plants of the same company, or consumed at the source. The percentages shown in this report are based on the total sales.

Three-fourths of the sales by blast furnace plants are made to industrial users, such as iron foundries and manufacturers of iron and steel products. Data collected for the census of distribution show that of the total sales in 1929, amounting to $198,254,000, 74.2 per cent, or $147,068,000, was sold in this way. Manufacturing plants sold 3.8 per cent, or $7,566,000 worth of goods to their own wholesale branches for resale to dealers and users. The remaining 22 per cent, or $43,620,000, was sold to dealers.

Of the above sales to dealers and users $82,027,000 was made through manufacturers’ agents, selling agents, brokers, or commission houses. Forty manufacturing plants sold through such agents, 20 of them selling their entire output in this way.

There are 105 plants included in the blast furnace industry engaged in the manufacture, from ore and scrap, of pig iron, ferro-alloys and castings made direct from the furnace. Of these 105 plants, 10 transferred their entire output, or consumed it at the plant. This report shows the sales channels used by the 95 plants which reported sales. The sale of other products made by these plants, such as slag, also the sale of electric current, is included in this report.
FORGING steels may be defined as those which are subsequently fabricated by forging, upsetting, piercing or pressing.

These steels are manufactured and marketed under the common nomenclature of either "commercial quality" or "forging quality." To give a more comprehensive idea of the meaning of the two terms, each will be defined in the following article as to the qualities they must possess along with the mill practice.

The commercial grades are usually low carbon open steels, which are cast in ingots without the use of hot tops. There are a few exceptions, depending upon the manufacturer's interpretation of this term. By open or rimming steel is meant one which has not been degasified with aluminum, silicon or other elements. When the sizes permit, say 2 in. or over, they are rolled direct from the ingot into the finished size. Consequently, the result is the cheapest product which can be produced. On the smaller sizes the common practice is to chip, without pickling, the snakes and open defects from the billets and then reroll into the finished size. When a small extra is paid, the stock is more thoroughly cleaned in the blooms or billets and then rerolled into the finished size.

In all cases when commercial quality steels are purchased the surface of the product will contain numerous seams and defects owing to the method of manufacture. The usual guarantee for commercial quality covers only analysis, that is, the heat analysis is guaranteed to be within the specified range. Bar checks may vary outside the range specified, however, the average or heat analysis will be within. There is no responsibility placed on the part of the manufacturer as to freedom from surface defects, segregation, soundness or response to heat treatment. This steel is sometimes furnished to meet physicals in the hot rolled condition, especially in bar stock such as reinforcing bars—in this case the manufacturer is given his choice as to carbon range applied in order to meet the physical properties desired. These, however, are not guaranteed after reworking the stock. Commercial steel is used for relatively unimportant forgings which are not highly stressed or subjected to alternating stresses.

Forging Quality Steels

Forging quality steels, either plain carbon or alloy, are probably more generally used. All alloy steels fall into this class without being specified. These steels are usually guaranteed to be free from pipe, free from detrimental surface defects such as seams, slivers and scabs, and also free from excessive porosity; further, they should be within the analysis range specified and should respond to heat treatment.

In order to insure the above facts it is necessary to use special precautions in the making and handling of these steels. They are killed or degasified by the use of aluminum, silicon or other deoxidizing agent and cast into large end-up molds with hot tops. These molds are carefully inspected, cleaned, warmed and treated by spraying or washing the surface with materials for this purpose. They are fitted with hot tops which feed the shrinkage cavities and produce a large percentage of sound steel. It is important that hot tops be used to eliminate pipe, porosity and segregation in the ingot proper. After the ingot has been stripped from the mold, heated in the soaking pits, it is rolled into a bloom or billet, and cropped at both top and bottom. Usually about 15 to 25 per cent is cut from the top and 3 to 10 per cent from the bottom, depending upon the type of
and Testing of

FORGING

QUALITY

STEELS

steel and other conditions which govern the purpose for which the steel is later to be used. This cropping is done by large hydraulic or mechanical shears and it is the shear inspector's duty to continue cutting stock from the bloom until the pipe drag has disappeared and then take an extra .25 to 1 per cent to absolutely eliminate all pipe and detrimental un-

soundness. In some cases after this is done the bloom is cut into various lengths and the first or top cut kept aside to apply on orders where the very highest quality is not necessary. In cases of this kind it is customary for the purchaser to make arrangements to apply this special discard on other orders.

Going back to the ingots, it is often necessary to strip these from the molds as soon as they have solidified and charge them into the soaking pits. Sensitive steels, those high in carbon and alloys, are not allowed to cool down in the ingot sizes but are maintained hot from ingots to billets before cooling. Even the billets of these steels are placed in a pit and covered so that they cool slowly. This cooling requires from 24 to 72 hours depending on the size blooms and type of steel. This is done to protect quality.

After the billets are cold they are pickled in about 6 per cent H$_2$SO$_4$ acid solution at 190 deg. F. to remove the scale and facilitate inspection. The surface defects are removed by chipping—this is done with pneumatic hammers; it must be supervised in order to remove all defects and eliminate improper chipping which might produce laps on rerolling. In some cases the entire surface is removed—this is necessary on special high grade steels to procure the required surface in the finished product. In cases where the stock is too hard to chip, the billets are ground. The care and thoroughness exercised in cleaning the billets reflect upon the quality of the final product.

After cleaning, the billets are carefully reheated for rerolling—here care must be exercised for if they are heated too rapidly the center is ruptured because the outside expands away from the inside. Large billets, especially those of sensitive steel,
should never be charged into a furnace which is up to forging or rolling heat—they should be heated in a continuous furnace or charged into a cold furnace and brought up to 1400 deg. F. before transferring to a furnace which is up to rolling temperature. This is one point which is very often overlooked in the forge shop and only found when the part has cracked on heat treating or the rupture found on machining.

At regular intervals during rolling, representative bars are pickled and inspected; if these show laps, overfills, scratches, guide marks or other mill troubles, the mill is stopped and the trouble remedied before proceeding further. However, if these indicate that there is no mill trouble and the surface is free from seams, the whole rolling is inspected without pickling. The bars showing seams are chipped or ground, depending upon size, shape and further processing. If inspection indicates that the stock is not up to standard for the purpose intended the whole rolling is pickled, inspected and cleaned. After the inspection department has passed the material it is ready for shipment. In order to release the stock, the inspection department should be fully acquainted with the processing in the customer's plant so that proper standards are set up.

Tests in the Forge Shop

After arrival of the material at the forge shop, probably the first step is to take drillings for check analysis. There are standard methods for this procedure so it is not necessary to explain them here. (See A.S.T.M.) Notwithstanding the standardized methods of sampling and checking carbon, this is one of the common causes of complaint. There are several reasons for this. When a steel mill accepts a five point carbon range, for illustration, .45 to .50 carbon, this means that the mill will apply heats with ladle analysis for carbon falling within this range. Those who are familiar with steel mill practice know that it is extremely difficult to hold the ladle analysis within five points of carbon. Now reviewing further, it is known that in the freezing of an ingot a skin freezes first and the center more slowly; according to physical chemistry, the last part of a solution to freeze will contain more of one of the elements than the other. The steelmaker is not a magician and cannot upset the laws of physical chemistry, hence, when an ingot freezes there is bound to be a variation in elements, especially carbon, regardless of how uniform the heat is made in the furnace. There are some who cannot understand why if a heat is invoiced as .47 carbon they will get bar checks as low as .44 and as high as .50. Also, taking into account the variation of determining carbon on standard samples, the steel mill cannot be expected to furnish steel with bar analysis within a narrow range when checks by different laboratories on the same sample vary two to three points. Some years ago several companies attempted to furnish...
October, 1931

Blast Furnace Steel Plant

1351

steel within a narrow range on bar checks and even analyzed every billet but still could not hold within the range.

Customer Cooperation

Some customers purchase a certain type of steel over a wide carbon range and then divide this spread into five point ranges. These ranges overlap so the mill can select heats within the five point range. This cooperation greatly assists the customer in procuring his desired ranges and assists the mill in making and disposing of the steel. To make steel within a five point carbon range, especially medium and higher carbon steels, is an impossibility. The variation in carbon is greater the higher the carbon content of the heat and vice versa. In regard to checking the other elements, no great difficulty is experienced between producer and user.

As many already know, purchasing steel to a five point carbon range or narrow alloy content does not eliminate the necessity of keeping a heat separate for heat treatment. It is the practice of many large plants to maintain the identity of a heat up to the finished product in order to obtain uniform results. All heats of the same chemical content do not require the same drawing temperature to produce like physical properties. This is owing to other characteristics of the heat not governed entirely by the analysis. After the heats have been approved as far as chemical analysis is concerned, there are other standards to be passed depending upon the requirement of the final product.

Before unloading the car, samples are often pickled and inspected for surface defects. If seams are apparent, small slugs may be cut from the bars and hot upset. These pieces are usually one and one-half to two times the diameter in length. This procedure indicates the depth of the seams and it can then be determined if the stock is suitable for the particular part to be forged. It is preferable to inspect the stock before starting in production, for very often after the forgings are made it is impossible to place definitely the responsibility, as forging defects to the casual observer may appear to be owing to the steel. Inspection before forging also gives the steel manufacturer an opportunity to inspect the material and recondition it if necessary before it is cut into multiples or made into forgings.

The Shearing Problem

One of the most discussed points at the present time is cold shearing quality. What size and analyses can be definitely guaranteed to cold shear in the hot rolled condition is a question often asked. There can be no specific answer to this question as conditions vary so widely in the various manufacturing plants that each is an individual problem. The size and type of shear is important, the alligator shear is not used to any extent and does not produce a good cut. In the press type of shear the capacity of the shear materially affects the cold shearing quality. Steel that will satisfactorily shear on a large shear may crack on a smaller shear, even though it is within the capacity of the shear.

No great amount of work has been published on shear blades as to design—in many cases a formed or shaped blade should be used and would produce the desired results. The clearance of blades also is a factor and should be studied. Some shops have greatly improved their practice within the last two years and are satisfactorily cold shearing larger sizes while others cannot seem to shear satisfactorily comparatively small sizes.

The next question asked by the consumer is why not "pit anneal or bury" the stock? It was a mistake for the steel mills to tell the purchaser that there was such a thing—pit annealing or burying is nothing but slow cooling and is used on high carbon and alloy steels to protect the quality of the product and not primarily to produce softness. The purpose of pit annealing is to prevent as far as possible internal ruptures, surface checks and similar troubles which result from improper and non-uniform cooling of large sections. This method of handling, while in large quantities produces a softer bar, does not guarantee good shearing quality. Probably all the large sizes of alloy steel that the forge companies have purchased in the last five to six years have been handled in this manner. Nevertheless, there are still
some steels and sizes which must be furnace annealed for cold shearing. There are a few types which should be hot sheared and large sizes cold sawed. The manufacturer will have to determine which is the most economical for his plant and equipment.

Depending upon the requirements imposed by the purchaser, many tests for quality and certain characteristics are made.

The deep etch test or macro etch is specified in many cases. For the detection of pipe, excessive porosity and ruptures in the steel, this test is admirably suited. However, rejection is often made on account of the slight pattern which is visible. This is owing to the difference in freezing of the center and edge of the ingot and is not harmful. Over this point there is considerable controversy—microscopic examination shows practically no difference between center and edge. Tests have proven this condition has no detrimental effect on the forgings.

The usual procedure in making the macro etch test is to cut a disc or slice the full cross-section of the billet and, after facing one side, etch in 50 per cent solution of HCl at 140 to 170 deg. F. The length of time must be determined by trial, as all steels do not etch with the same rapidity. If the sample is over-etched, false impressions will be given and the entire surface about 3/4 in. deep must be removed before retesting. In case a sample is over-etched it is preferable to cut a new sample rather than reface the old one.

Along with etch tests, microscopic examination is usually requested. The greatest difficulty in microscopic examination is to obtain a properly prepared sample. Many tons of steel have been rejected or held up owing to the improper polishing of samples. There are several general articles on polishing so it is unnecessary to review the proper procedure here. It is not a very difficult problem to rate the steel for cleanliness on the microscope as several companies have prepared standards upon which they grade a steel. The most important point is to set up proper standards and to know definitely the type of inclusions and amount which are really detrimental. In passing on inclusions under the microscope a great deal of judgment must be used. The same standards cannot be applied on large sizes as are applied on small bars. This is one point which must be considered in drawing up standards and passing on steel. In many places microscopic examination for inclusions is requested when it is not necessary. There are some parts where microscopic inspection is essential, the most prominent of these being ball bearing steels.

The McQuaid-Ehn test has been used since 1922 and still is not thoroughly understood by a large majority. When it first came out it was a means of grading steel as to its ability to harden free from soft spots. That is, steel which would not harden was called “abnormal.” Since that time steel mill practice has improved and the large percentage of abnormal heats eliminated so that today the Ehn test grades normal steels according to their grain size. Since the grain size rating depends upon a standard time-temperature cycle, care must be taken that all tests are run on the same cycle and all ratings made at the same magnification. In general, the

(Continued on page 1369)
HAIR CRACKS on the SURFACE of SHEETS

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PART IV

As Barba and Howe\textsuperscript{7} state, the steel sprayed during casting forms a crust on the mold wall, which cannot be removed by the rapidly cooling top layer of the rising steel, and thus locally reduces the strength of the surface of the ingot. The oxidized particles of steel have the same effect as the mold scale adhering to the walls of the mold.

In order to investigate the effect of the steel spray (which is unavoidable even on bottom casting) on the surface quality of the blooms, new carefully cleaned molds were set up for heat 15 (0.09 per cent C, 0.51 per cent Mn, 0.042 per cent P, 0.025 per cent S, 38.8 kg. strength and 28.5 per cent elongation). This was in order to exclude any effect caused by old or dirty mold walls. In every second mold, sheets 1 mm. thick were suspended and held about 20 mm. from the wall by spacers, so that the steel spray could be caught. The casting was done in the usual manner. For the simultaneous investigation of the effect of the rolling temperature, this heat was put in two reheating furnaces. On comparing the ingots cast with and without the protective sheet it was seen that two of each kind of ingots had surface cracks. Accordingly, the surface cracks do not seem to have been caused by the spray during casting. This is not astonishing because the outside of the ingot, to which the spray adhered, burned off during heating in the reheating furnace.

Appearance of the Ingot Fractures

The presence of blowholes is very disadvantageous for the ingot as the ultimate strength is greatly influenced by the lack of cohesion of the material in various places, and according to Preuss,\textsuperscript{7} on loading in tension and compression there are considerable increases in stress at the boundaries of the voids. According also to Monden's investigations, the type and position of the surface blow-hole ring is an essential factor in the rolling properties of the ingot. He observed that the best ingots on rolling were those that had a strong edge layer free from blow-holes with a ring under it of comparatively few large blow-holes. According to Oberhoffer\textsuperscript{9} the distance of the edge blow-holes from the top of the ingot (disregarding the initial gas content of the steel) depends on the rate at which solidification took place, and therefore essentially on the casting temperature.

Fig. 15 shows the longitudinal fracture of the sixth ingot from heat 9888 (0.09 per cent C, 0.47 per cent Mn, 0.040 per cent P, 0.034 per cent S, 36.2 kg. strength and 25.0 per cent elongation) which had been found to be strongly cracked on the surface on rolling. Fig. 16 shows the fracture of an ingot from the third mold set of heat 9942, which also showed surface cracks and whose composition was given in Part III.

Figs. 15 and 16 show that in no case can the position of the edge blow-holes be the cause of the cracking of the surface of the ingot. The appearance of the fracture in both ingots is entirely as usual.

*Translation from the Archiv fuer das Eisenhuettenwesen. Address at the annual meeting of the Vereins deutscher Eisenhuettenleute.
and must absolutely be designated as good. With an average thickness of the edge zone free from blow-holes, of at least 20 to 30 mm., the edge blow-holes are comparatively weakly developed. On heating in the reheating furnace, the surface of the ingot cannot be melted down to such an extent that it would crack on roughing by opening up the edge holes. As usual, the loss by burning in the reheating furnace was 3 to 4 mm., and accordingly did not extend to the edge holes.

Heating the Ingots and Roughed Blooms

1—The standing time of the ingots. By standing time we mean the time that elapses between the pouring and the placing of the ingots in the reheating furnace. Gathmann\(^\text{4}\) states that it is especially important in the production of high-grade steel. In order to study the effect of ingot stripping on the action during hot-working, the heats were arranged in the order of their standing time and the average yield was calculated for heats that had stood for an equal period of time.

2—Time of heating in the reheating furnace. The rate of heating of the ingots in the reheating furnace, according to Gathmann,\(^\text{4}\) has an effect on the quality of the steel. In order to show any relation between the appearance of the defect and the duration of the heating of the ingots in the reheating furnace, the heats, as in the last experiment, were assembled according to the duration of heating. No relation was found to exist.

3—Method of heating. Starting with the assumption that uniformly good heating of ingot as well as bloom in general would have a great influence on the action of the material on hot working, and on the character of the surface in particular, experiments were made in order to see how the material was heated in the different heating furnaces. For this purpose half of several heats were heated in the preheating furnace, roughed, heated in the push furnace for the sheet rolling, and then finished in a second heat; while the other half, avoiding the reheating and push furnaces, were heated in the furnace for the armor plate rolling mill and rolled in one heat. Nothing was found from the standpoint of the furnaces used for heating.

Although from the 48 ingots heated in the reheating and push furnaces, 16.7 per cent of the sheets contained surface cracks, the 46 rolled ingots from the furnace of the armor plate rolling mill showed only 8.7 per cent and much less intensely cracked sheets. This result is worthy of attention and will be discussed more in detail later.

4—The effect of the flame in the reheating furnace. The effect of the flame on the surface of the ingot in the reheating furnace is shown especially in the scaling of the ingot. This shows that iron has a great tendency to combine with oxygen and this tendency increases with the temperature. In the reheating furnace where there is a mixture of oxygen, nitrogen, carbon dioxide and possibly water vapor, the oxygen is removed and the iron is covered very quickly with the formation of scale. Therefore, it would be desirable to have a neutral flame which also must be desired for thermo-technical reasons. But it is hard to get this in actual practice, because we always must have a certain excess of air. Since large amounts of steel are lost by improper furnace operation, that is, by the formation of large amounts of scale which reduces the sound metal thickness of the ingot, and which may be harmful to the surface of the sheets, an attempt was made to determine the effect of furnace operation.

For this purpose, half of heat 57 (0.17 per cent C, 0.46 per cent Mn, 0.040 per cent P, 0.038 per cent S, 43.4 kg. strength and 26.0 per cent elongation) was placed in two different reheating furnaces, one of which was heated with a strongly oxidizing flame and the other with a reducing flame. On roughing, the six ingots from the former furnace three were found to be free from surface cracks and four were without defects from the six ingots in the latter furnace. This result confirms the earlier assumption that the usual sound metal thickness of the ingots is great enough and therefore endures good sweat-
ing. The type of flame has no effect on the appearance of surface cracks.

Rolling

1—Rolling temperature. According to Monden\textsuperscript{16} the relation between red-shortness and temperature can be explained as follows: since red-shortness depends directly on the oxygen content of the mild steel, on increasing the temperature conditions must be set in that can annul the action of the oxygen. If we recall the finding of Oberhoffer and d'Huart,\textsuperscript{41} that iron has a certain dissolving power for oxides, it seems correct to assume that this dissolving power is noticed at the temperatures used, and therefore it is only a short step to the idea that red-shortness is caused essentially by the undissolved oxides while the dissolved oxides are harmless in this respect. Monden has emphasized his opinion by experiments.

In the investigation of the hot-workability of a chrome-nickel steel, Oertel and Richter\textsuperscript{32} have also found an increased tendency to form cracks with a rolling temperature that is too low. A pronounced increase in the frequency of the cracks was observed when 1100 deg. was exceeded as the temperature of the first pass.

This result confirms the observations made earlier by Ledebur,\textsuperscript{42} that the tendency to become red-short decreases with higher rolling temperatures. Under these conditions it seemed right to make experiments on the relation of the surface defect to the rolling temperature.

For this purpose, half of the ingots from four heats were rolled at 1280 deg. C. and the other half were rolled at an initial temperature of about 1100 deg. Seventy-five per cent of the blooms that were rolled at the higher temperature and only 39 per cent of those rolled at the lower temperature had sound surfaces. Therefore the rolling temperature seems to exert a great influence on the appearance of the defect, but it cannot be the only cause of the defect.

In order to test the effect of this result of roughing on the quality of the sheet surface, six ingots from heat 3543 (0.10 per cent C, 0.61 per cent Mn, 0.042 per cent P, 0.019 per cent S, 40.1 kg. strength and 23.0 per cent elongation) were roughed at about 1280 deg. and 1100 deg., allowed to cool, inspected closely, and then put into the push furnace, heated thoroughly again, and then the rolling was finished. All the blooms from the six more strongly heated ingots were good after roughing, but the sheets rolled from them had surface cracks on one side with the exception of one. Five blooms from the six ingots that were heated less had cracks on one side, and one bloom had cracks on both sides. The sheets were also cracked, four on both sides and two on one side.

This result was astonishing in so far as it was the first time that it could be proven perfectly that cracked sheets could come from blooms that had perfectly sound surfaces after roughing. Accordingly, in addition to the roughing temperature, there must be some condition in the further working of the roughed bloom that causes the defect on the sheet.

The correctness of this assumption is also indicated by the result of the corresponding large scale experiment. Here the heats with approximately the same temperature on roughing were tabulated in groups and the average yield of blooms with sound surfaces, sheets and tensile test-pieces per group was calculated. Since it was difficult to measure the temperature of each of the many thousands of ingots, it was estimated according to the degree of sweating of the ingot and the division into groups was made on this basis. It was determined, in agreement with the results of the previous individual experiments, that the temperature was not the only cause of the cracking of the surface of the ingot on roughing, and that the character of the surface of the finished sheet does not depend on this temperature alone.
As was mentioned in the beginning, there is a lower limit to the rolling temperature according to the character of the material at a given reduction in height. Conversely, at a given rolling temperature there is a lower limit for the permissible reduction in height, which causes a loosening of the structure if it is exceeded or not reached.

To investigate the extent to which the reduction in height has an effect on the action of the sheet ingot on roughing, was the purpose of the following experiments. Heat 54 (0.18 per cent C, 0.56 per cent Mn, 0.044 per cent P, 0.035 per cent S, 45.7 kg. strength and 220 per cent elongation) was put into two reheating furnaces and, as in the previous single experiment (heat 3543) half was roughed at a higher, and half at a lower temperature. Only three hotter and three cooler ingots were roughed in the ordinary way. The first two passes were upsetting passes in the first groove (Fig. 5) which was only to give the ingot its conical shape. Then in the bloom groove without turning, there were eight to ten flat passes with a reduction of about 30 mm. Then the ingot, was raised, upset in the first groove, turned and rolled to the end in the bloom groove with an average of 20 to 25 mm. reduction. Therefore in the experiment constant pressures were used. The rolling of the six test ingots was exceptional in so far as the three hotter ingots were rolled with greater reduction, and the three cooler ingots with less reduction than usual.

As regards the surface of the roughed blooms, it need only be said that the more strongly heated ingots were better and the ingots rolled in the usual way were worse than the test ingots. On the basis of this result it seems possible, by correct selection of the reduction in thickness corresponding to the rolling temperature, to avoid a loosening of the structure that must result in cracking of the surface of the blooms.

3—Cooling water. In the discussion of the surface defect described here, Meerbach assumes that its formation might possibly be explained by the quenching action of the cold cooling water.

In order to test the correctness of this view, four ingots from heat 57 (0.17 per cent C, 0.46 per cent Mn, 0.040 per cent P, 0.038 per cent S, 43.3 kg. strength and 26.0 per cent elongation) were rolled as usual, but without cooling water. The roughed blooms were sound on the surface. Of the other eight blooms rolled with cooling water, four had cracks.

On the basis of this experimental result, the quenching action of the cooling water cannot be denied a certain influence.

Comparisons with Material from the Steel Foundry

As was mentioned in the beginning, the sheets of material from the cast steel plant showed the defect less frequently than those rolled from the ingots from the new steelworks. It also was stated that the material from the cast steel plant, avoiding the reheating furnace and push furnace, was rolled in one heat from the furnace of the armor plate rolling mill, while the ingots from the new steelworks were first heated in the reheating furnace, rolled on the blooming mill, heated again in the push furnace and then rolled until finished.

It seemed advisable to investigate the effect of the method of working on the formation of the defect, particularly as it was already stated that when the ingots from the new steelworks were put directly into the furnace of the armor plate rolling mill, the surfaces of the sheets were considerably better. A comparison of the materials from the two steelworks was best done by repetition of the above experiment with ingots from the cast steel plant.

For this purpose seven heats from the cast steel plant were taken, half being rolled from the reheating furnace and push furnace, and the other half from the furnace of the armor plate rolling mill. The result was the same as with the material from the new steelworks. Only 69 per cent of the sheets rolled from ingots heated in the reheating furnace and push furnace had sound surfaces, while the ingots from the furnace of the armor plate mill gave good sheets.

As a result of these two experiments, it seems more than probable that the surface cracks are not defects in material, but in working.

Metallographic Investigations

For more accurate knowledge of the defect and its cause, many metallographic investigations were made during the experiments, on which we shall report briefly.

Heat 9177 (0.07 per cent C, 0.48 per cent Mn, 0.030 per cent P, 0.035 per cent S, 37.1 kg. strength and 27.5 per cent elongation)—Fig. 2 (Part I) shows the surface of a tensile test-piece from this heat, exact size, and Fig. 17 shows a cross section of it. The cracks are filled with oxides, and there are small inclusions between these oxide veins or in their immediate vicinity.

Heat 9199 (0.13 per cent C, 0.55 per cent Mn, 0.040 per cent P, 0.029 per cent S, 43.5 kg. strength and 20.0 per cent elongation)—Fig. 18 shows the surface of a bloom with many reticular cracks. Fig. 19 shows the etched cross section of the surface in the longitudinal direction of the bloom. The surface is greatly cut up. Fig. 20 is also a section through the bloom, but in its transverse direction. Fig. 21 is a picture of the part in Fig. 20, etched a second time.

It seems proper to give here the results of the metallographic investigations.

Many microscopic investigations of the defect led to the assumption that the oxide accumulations in the cracks and in their immediate vicinity at the surface cannot be the cause of the cracking of the surface of the sheet, but are only a manifestation of the result of the cracking. The comparatively shallow depth of the crack indicates this. The appearance of the immediate vicinity of the defect also

(Continued on page 1361)
A By-Product Coke Plant
for a 1000-Ton Blast Furnace

In the design of a coal handling department it is necessary, at least to some extent, to have knowledge of the coal to be used in the coking process. The class of coal used has some influence on the storage problem, while the number of coals to a large extent determines the class of storage equipment necessary.

Coals

In the design of an ideal coke oven plant, where all conditions relating to the manufacture of coke could be controlled definitely, we would, of course, use only one coal and it would be necessary for the coal purchasing department to purchase only those coals that could be used alone in the manufacture of blast furnace coke. A plant of this kind would be simple in its operation and construction, but would so restrict the purchasing agent in the number of coals available that in a short time he would probably find it necessary to pay a premium for such coals. If we assume that a plant using only one coal could be operated without a pulverizing system and mixer bins and the simplified construction would involve a saving of $100,000.00, we would have a saving in the fixed charges per year of approximately $15,000.00. Assuming that this coke plant would use approximately 500,000 tons of coal per year, we could only afford to pay 3 cts. more for a coal that did not need a coal preparation plant than we could afford to pay for coals that needed a preparation plant costing $100,000.00 to manufacture the same quality coke. These figures are only given as an illustration so that some idea of premium may be had. Inasmuch as there would be some saving in labor involved, we could easily state that at no time could we afford to pay more than 10 cts. a ton for coal that did not need much preparation. As the tonnage of the plant increased the premium possible would decrease. It seemed to us that to restrict the coal purchasing department to very few coals and the possibility of it being necessary to pay a premium probably in excess of 10 cts. per ton of coal, together with the fact that the operations in the coke plant would not be as flexible as an operator cares to have them, the ideal arrangement of having one kind of coal is somewhat impossible. Because of the above fact, it was decided that the coke plant be designed to use at least two coals.

Assumptions

The assumptions made in the design of a coke plant to fit a 1000-ton blast furnace were as shown in Table I.

Storage

It is also assumed that this coke plant was to be built in this district and, no doubt, located on the lakes where lake navigation is available. Under these conditions the winter months mean non-navigable months which are December to April inclusive.

On November 28, 1930, the Blast Furnace and Coke Association of the Chicago district held a meeting at which five papers bearing on different engineering features of A By-product Coke Plant for a 1000-ton Blast Furnace were presented. Each of these papers was prepared by a committee composed of officials of coke oven plants in the Chicago district. These eight papers, together with a discussion of them, have been published in an illustrated booklet which can be obtained for $2.50 from E. J. Gardner, Inland Steel Company, East Chicago, Ind.

The paper here given concerns the coal and coke handling equipment.
There is in the storage of coal the advantage of mixing coals so as to eliminate some of the changes prevalent in a series of smaller shipments.

Another advantage in the storing of coal is that it is the experience of companies storing quantities of coal that the average over-run will be from 1 to 2 per cent. This additional coal offsets some disadvantages in the storing of coal.

The greatest disadvantage in the storing of coal is that the majority of coals in aging, lose or change the quantity of by-products produced, so that some operators feel that the loss in by-products, together with the expense involved in the storage of coal, offsets to a large extent, if not all, the saving made in lake transportation over rail transportation.

Storage Equipment

Owing to the cost of equipment, together with the fact that a coal handling bridge would be constructed.

Table I

| Analyses of Coal | H₂O % | Sulphur % | V. M. % | Ash % | %
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<td>3.5</td>
<td>.60</td>
<td>18.00</td>
<td>6.00</td>
<td>Low volatile</td>
</tr>
<tr>
<td>3.5</td>
<td>.60</td>
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<td>6.00</td>
<td>High volatile</td>
</tr>
<tr>
<td>3.5</td>
<td>.60</td>
<td>30.00</td>
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Analysis of Coke

<table>
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<th>Analyses of Coke</th>
<th>H₂O %</th>
<th>Sulphur %</th>
<th>Ash %</th>
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<tbody>
<tr>
<td>2.50</td>
<td>.60</td>
<td>under 8.00</td>
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<td>10.00</td>
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<td>13.00</td>
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<td>under 8.00</td>
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<tr>
<td>3.50</td>
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similar to the bridge for the ore dock, thus providing for greater reliability in handling materials for both the blast furnace and coke plants, it is recommended that the coal storage equipment consist of a dock and storage yard similar to that constructed for the blast furnace plant. At the present time the dock need only be built 500 ft. long, which is one-half of the ultimate size recommended, but would hold at least 150,000 tons of coal or more than one-half of the winter's supply. The dock equipment would consist of a coal bridge for storing and reclaiming coal for plant use. There would also be provided one coal stacker at the shear leg end of the bridge for the purpose of storing coal received by rail. At the shear leg end of the bridge there would be a reversible conveyor that could take coal either from storage or into storage; the coal from storage being delivered onto a belt conveying it to the base of the mixer bin where a transfer point would be located to deliver coal into the preparation system.

A connection would also be provided between the coke belt to the blast furnace and the coal storage conveyor to allow the stocking of coke on the dock, thus making possible an economical stocking and reclaiming arrangement. The coal bridge would be so constructed that coke could be reclaimed by means of the bridge and delivered onto the belt going to the furnace pockets.

Under same conditions it might be desirable to reclaim stock coke for the furnaces and rescreen or mix with production coke at a uniform rate. This could easily be done by loading stock coke into cars suitable to be dumped on the coke wharf, thus definitely mixing production and stock coke and assuming a uniform size of each.

The track hopper for receiving rail coal would be so constructed that ultimately a car dumper could be installed. Coal from the track hopper would be delivered by a system of conveyors to a transfer point from which coal could be directed to storage or into the coal preparation system. We feel it would be important to be able to stock coal received by rail.

Serious consideration was given to the unloading, storage and reclaiming of coal by means of unloading tower and drag scraper equipment. Preliminary estimates were made comparing the cost of the two installations and what little difference did exist was felt to be outweighed by the fact that a coal bridge also serves as a spare for the ore bridge and vice versa. There are some drag scraper equipment plants operating successfully, but the tonnage of materials to be handled by both the coke and blast furnace plants makes the interchange of equipment a real asset so long as the difference in cost is not too great.

The installation of a larry car for conveying coal from the bridge to the coal preparation system and from the rail coal hoppers to storage was also considered as against the belt equipment recommended. It is doubtful whether larry equipment can be installed for much less money than a single conveyor structure that will do both of these duties as economically when the ultimate capacity of the plant is realized.

When it becomes necessary to increase the storage of coal with the growth of the plant it will be necessary to extend the dock bridge tracks and install another conveyor similar to the equipment already considered storage equipment. Some of the details on the drawings shown might not allow the interchange of bridge equipment between the coke and blast furnace plants because of the furnace trestle, but we feel that such matters could be worked out without additional expense to either plant.

Coal Preparation

Coal would be conveyed from the transfer point under the mixer building to the breaker building and would flow through a 12 x 17 breaker and over a
Diagram of coal and coke handling equipment for the by-product coke plant

screen which would screen out coal under 3/16 in. in size. Material larger than 3/8 in. in size would flow into and through a standard coal pulverizer capable of adjustment to pulverize coal to 90 per cent through a 3/8-in. screen.

This equipment would be capable of preparing coal at the rate of 200 tons per hour, although the belts would be installed to carry 400 tons per hour. When the plant was expanded beyond 1400 tons per day, the additional tonnage could be handled by working the coal preparation plant an additional number of hours or a second breaker and hammer mill could be provided, which would furnish sufficient equipment for the ultimate size of the plant of 5600 tons per day.

To prepare coal for a 5600 ton plant, it would be necessary to work the coal preparation plant 16 hours, which allows ample time for repair work, delays, etc.

A belt is indicated for conveying bone coal from the outlet of the breaker back to the inlet which may or may not be installed, dependent on the kind of coal to be coked and the tonnage required. With certain coals, where the bone coal rejects are excessively high, the installation of a belt of this kind might prove profitable, or when the tonnage coked is sufficiently high to warrant an installation of this kind based upon the normal rejects. Bone coal could be, in any event, rejected into a car and for small tonnages this is perfectly satisfactory as the car could be rerun through the entire system, or, in some plants, used for fuel purposes.

From the breaker building coal would be conveyed to the top of the mixer bins after it was properly pulverized, and then run into either of four compartments, although only two would be necessary. Each of these compartments would have a capacity of 350 tons, and it would then be possible to prepare a daily supply of coal without digging any one coal more than once a day. Extra bins have been provided because of the fact that the majority of plants now in operation have in times past found it desirable to have additional mixing bin equipment, either for the charging of some other coal, which they felt would be to their advantage, or for using the mixer bin for an additional storage bin for oven supply. Coal from each of the mixer bins would be drawn off below through feeder belts, so constructed that percentages of various coals could be controlled within 1 per cent. All these feeder belts would deliver onto a common belt conveying coal to the top of the oven bin.

Oven Coal Bin

The coal storage bin at the ovens would be of 1400 tons capacity, which would be doubled in size with the addition of another battery. Prepared mixed coals delivered to the top of the coal storage bin would flow through a paddle mixer onto the lower level of a scraper conveyor. The scraper conveyor would be so constructed with doors that coal could
flow through the bottom into the coal storage bin. The scraper conveyor also would be totally enclosed to eliminate drafts through the bin and reduce fire hazards.

Coal on flowing from the bottom of the scraper conveyor would be divided by means of chutes, constructed so that they appear similar to a truncated house top. This would divide the coal into three piles, the apex of each pile being directly above the withdrawal gates in order to get the least amount of segregation, together with the maximum amount of mixing on withdrawing the coal from the bin into the larry car. In addition to a bin constructed as described above, the coal delivered to the oven storage bin should be pulverized quite fine, so as to eliminate segregation of coal to some extent.

**General**

All coal handling machinery would be of anti-friction bearing, enclosed type, so as to eliminate dust, wear and lubrication difficulties. All troughers would be of the three pulley, anti-friction bearing type, and all galleries would be completely sheeted with the side sheeting on the inside of the steel work.

Windows are recommended rather than louvers. There would be a walkway of concrete construction on each side of the belt.

A saving would be possible by constructing open galleries and covering the belts in a manner to protect them from the weather. Offsetting this saving would be the very unsafe condition of walkways exposed to winter weather, and the possibility of handling lump coal would not make the covering of a conveyor in a closed manner a safe operating condition, particularly so with incline conveyors. It is a distinct advantage to have conveyors exposed, not only for inspection and repair, but to allow space for material in the event of a serious plug up. The operation of a coal handling department is too essential to the operation of a coke oven plant to tolerate conditions of possible trouble. If the construction of a gallery is to be cheapened, it may be satisfactory to shorten the siding so that air space is left either on the top, bottom or both ends of the siding, but very little could be saved in this manner.

Recently there has been considerable study put on conveying or elevating equipment other than belt conveyors. The possible use of skip hoists in coal handling equipment was considered with the following results: A capacity of 400 tons per hour is a rather severe task for a skip hoist. Very little, if any, saving can be made in capital expenditures by using skip hoist equipment, and the fact that it is a new application without much gain does not recommend it. Skip hoist equipment may apply to small installations, but we believe it is at the present time limited to that field.

At the present time we are not recommending a car dumper, inasmuch as there would be only 50 per cent of the winter coal to be received by rail, which amounts to about 700 tons per day or a little more than 10 car loads. When the tonnage of coal received per day in the winter time would become a burden, or expense, because of the frozen condition of the cars, other means of dumping, such as a car dumper, should be considered. We do not feel it is necessary to recommend the type dumper, since we have made only future provision for same.

A thaw shed is not recommended, as it involves considerable expense and benefits the coal handling only a few days in the year. We do not feel that it would be necessary to install a weightometer for the sake of checking coal stocks, inasmuch as it would be more important that the weighing be done at the ovens which would give information of greater use.

**Coke Handling**

The coke screening station is to be designed to produce blast furnace coke, pea coke and breeze. One wharf, with a belt leading to a screening station, would be installed immediately, the screening station so constructed that a future wharf could be installed on the opposite side, and the screening station enlarged, thus providing two wharves and an ample number of screens when the ultimate size of the plant is realized.

Coke would be received from a hot car on a brick lined wharf 110 ft. long. The wharf gates would be about 30 in. wide, each gate to be provided with an individual chute which would direct the coke in the same direction the belt would be traveling so as to eliminate belt wear.

The wharf belt would convey the coke to the screening station and deliver the coke onto the scalping screen. The wharf belt and screens would be built for capacities of 125 tons per hour, which would be sufficiently large to care for 2800 tons coal per day. The scalping screen would be of the grizzly type with roller bearings, adjustable within limits of 3 in. x 4½ in. openings. The over-size coke would be delivered directly into a crusher separated from the grizzly screen. This crusher would be of the multiple knob type, belt driven and adjustable as to crushing size. A chute below the crusher would collect that coke which passes through the scalping screen and the coke passing through the crusher and deliver the total coke onto a finishing screen of the grizzly type with ball bearings and having openings of 1 in. square. The rejects or throughs from the 1 in. size screen to be delivered onto a conveyor that delivers the coke screenings to reciprocating screens having 1 in. square openings. This would allow for the wearing of the grizzly sizing screen without loss of product, as the reciprocating screen of 1 in. square opening could deliver its over-size either onto the furnace coke belt or into a separate car. This would also allow for the producing of two or three sizes of furnace coke if desired.

The rejects or throughs from the 1 in. size reciprocating screen would be delivered onto reciprocating screens having ½ in. square openings, which would separate the screenings into two sizes, pea coke and breeze. Both of these sizes would be delivered through chutes into cars on their respective tracks.
The furnace coke, which would be the over-size of the 1 in. x 1 in. grizzly, and might include the over-size of the 1 in. x 1 in. reciprocating screen, would be delivered onto a coke conveyor which would convey the coke to the coke pockets at the furnace.

The construction of the furnace belt from the screening station to the coke pockets would be of the open gallery type. That is, the coke belt would have a cover which covered the belt only and did not protect the walks. This belt, however, would be a comparatively flat belt handling sized material, thus eliminating possible trouble. In addition to this there would be a means of getting coke to the furnace pockets other than this belt, so that the cheapest construction possible would be recommended.

The conveyor gallery from the coke wharf to the screening station would be of the closed construction type, similar to that described in the coal handling.

Both the scalping and sizing grizzly screens would be constructed in duplicate, both screens in each case to be mounted on racks that would make each screen interchangeable with the other. All coke handling machinery would be of the anti-friction bearing, enclosed type. All motors would be totally enclosed, anti-friction bearing and interchangeable with those in the coal handling.

The belt control systems properly interlocked, constructed and so arranged that belts could be controlled from the most advantageous position would be necessary in order to facilitate operations and keep labor costs at a minimum in both the coal and coke handling. In the case of the coal handling it would be recommended that gas tight buttons and switches be used for fire prevention purposes while the same equipment would be used in the coke handling as a protection from electrical troubles.

Fire Prevention

Fire prevention would be especially essential in the coal handling. All conveyor galleries and buildings would be equipped with a sprinkler system automatically controlled. The conveyor immediately under the coal pulverizer should be tightly enclosed and separated into several compartments about 3 ft. long by means of canvas partitions, each one of these compartments to contain a fogging spray which would fog a minute quantity of water, thus precipitating the air float dust that would be made at this point. In this way we feel the cleanliness of the plant would be improved and the fire hazard reduced. Periodically throughout the entire year, when weather permits, all galleries, both coal and coke, should be flushed down, which would include steel structures and machinery as well as floors. Provision should be made for fire hydrants convenient to all buildings. We believe that the recommendations of the insurance underwriters should be carried out wherever it is possible to do so.

Dry Quenching

It is possible that within a short time dry quenching would be considered. A location is given for a dry quenching unit adjacent to the coke screening station. Should the operation of a dry quenching unit prove satisfactory, it might alter the decision to install the second wharf, replacing same with a dry quenching unit. However, the subject of dry quenching will be discussed in detail.

Hair Cracks on the Surface of Sheets

(Continued from page 1356)

indicates that the crack first forms on rolling and then its originally clean metal walls are oxidized by the penetration of atmospheric oxygen. The photomicrographs did not show a direct cause of the cracking of the surface.

Heat 9465 (0.09 per cent C, 0.54 per cent Mn, 0.031 per cent P, 0.042 per cent S, 38.3 kg. strength and 24.0 per cent elongation) in the same way as the previously described experiment on the effect of ingot heating in the reheating furnace on the quality of the ingot surface, ingot No. 10 of the heat was set aside after heating, but before roughing) and allowed to cool. After removing the scale the ingot actually showed a sound surface. Individual small voids led to the following investigation of the cross section of the surface of the ingot.

The imperfect places that, as stated, give the impression of small voids on inspecting the cooled ingot, do not penetrate very far into the ingot. Their appearance does not justify the assumption that they might be the cause of the cracking of the surface of the ingot.

In order to be able to test the inside of the ingot, the reserved ingot No. 11 was divided. The inside of the ingot was regarded as perfectly normal. The edge blowholes and solidification pores were rather deep.

The result of this investigation is especially noteworthy because all other ingots from this heat were greatly cracked at the surface on roughing. Since, in spite of most careful testing of the surface portions of these two test ingots, no difference could be found as compared with good ingots, it can safely be assumed that the reason for the cracking of the surface on rolling does not have to be sought in the quality of the material.

Reference

loc. cit., p. 326.
Stahl und Eisen, 1924, v. 44, p. 858.
loc. cit., p. 76.
Made in the Metallography Laboratory of the Wissenschaftliche Bergbau und Eisenhütten Gewerkschaft in 1925-26.

(To be continued)
Economies in the Design and Construction of Industrial Boiler Plants

By H. BLEIBTREU
Freyn Engineering Company
Chicago, Ill.

The production costs of 1,000 lb. of steam are under average conditions $0.30 to $0.50. Of this amount, $0.15 to $0.30 is for fuel, while the capital costs for interest and depreciation of the boiler plant vary with the load factor between $0.08 and $0.20. With cheap coal and low load factors, the capital costs may be equal to or even greater than the fuel costs.

With the high efficiencies of modern boiler plants, the fuel costs could be reduced only slightly. On the other hand there are a number of means for further decreases in the capital costs.

Significance of Low Investment Costs

Although the importance of low building costs has always been more emphasized in American practice than in European practice, this does not mean that everything that could be wished for has been attained. In fact, the trend of development in the power plant field clearly points to the ever-increasing importance of low investment costs.

There are two main reasons for this statement: the first is that owing to the increasing interconnections of industrial plants with the transmission systems of public utilities, the load factors of the industrial power plants invariably decrease. Several steel plants and coal mines, for instance, have shifted the operating time of certain rolling mills or mining pumps to the night hours in order to take advantage of the cheap night rates offered by the public utilities. The industrial power plant thus working at very light loads during the night, and being relieved to some extent of the plant load in the daytime, will be available for public peak load current, which can be sold at an attractive premium. Because of such set-ups, the industrial power plant will not only survive but will become an essential member among the power producers of the country. The outstanding features of these plants are rather large capacities, low investment costs and very elastic load features, while heat economy is a secondary consideration.

The other reason for the increasing importance of low investment costs will be realized in connection with the question whether it would be advisable to increase the depreciation rates. The rapid development of steam engineering as brought about by high pressures, powdered fuel, regenerating cycles and large boiler units with high ratings, has by no means reached its climax. We have every reason to believe that the future will bring about new and unexpected developments. Naturally, this will hasten the obsolescence of present plants. Even now there are cases on record where in building industrial power plants, low pressures, small units and even obsolete coal handling methods had to be adhered to for the reason that the original plant had not been written off the books, and therefore had to be maintained and operated in conjunction with the new equipment.
October, 1931
Blind Furnace Steel Plant

Table I is an analysis of costs of modern industrial boiler plants. The two largest items are the building with the coal bunkers and the boiler with superheater and soot blowers. The total cost of the boiler plant varies between $120 and $200 per b.hp., with $175 as a fair average.

There are several ways by which savings in the costs of boiler plants could be effected.

One way is the standardization of boilers and boiler house equipment. Further considerable savings can be obtained by careful design of the general layout and proper allocation and dimensioning of coal handling facilities and bunker space. Last but not least, careful planning of both the designing and contracting engineers will result in greater economies than is generally realized.

**Standardized Equipment**

There is little to be said about standardization, as American practice fully realizes its importance. In Europe, high pressures and the desire to make full use of radiant heating surfaces have led to a large variety of new boiler designs. Being far from standardized, these boilers are generally rather expensive and, therefore, to a large extent defeat the advantage they have from merely a thermo-dynamic point of view. American practice has proved that the conventional boiler types with certain changes lend themselves readily to high pressure and radiant heat transmission. Therefore, economical possibilities must be looked for more on the side of improved manufacturing methods than, as in Europe, in the realm of new types. By this the writer does not want to imply that certain European features, such as the two-drum boiler, may not find a field in America. It will be well, however, to wait until one or two definite types have been crystallized from the rather conflicting views of European boiler manufacturers.

**General Rules for Economical Layout**

In laying out a boiler house, two general rules should be observed:

First, the cost of the building above foundations being mainly determined by the volume, the cubical contents of the building should be as small as possible without impairing the accessibility of the various parts. Experience shows that building

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**Table I—Analysis of Costs for Industrial Boiler Plants**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost per b.hp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Foundations for building equipment</td>
<td>$ 8 to 12</td>
</tr>
<tr>
<td>2—Building and fuel bunkers</td>
<td>$20 to 40</td>
</tr>
<tr>
<td>3—Boilers, superheaters, soot blowers (erected)*</td>
<td>$20 to 35</td>
</tr>
<tr>
<td>4—Economizer (erected)*</td>
<td>$10 to 20</td>
</tr>
<tr>
<td>5—Air heaters (erected)</td>
<td>$10 to 15</td>
</tr>
<tr>
<td>6—Settings</td>
<td>$ 6 to 10</td>
</tr>
<tr>
<td>7—Coal firing and forced draft equipment</td>
<td>$12 to 18</td>
</tr>
<tr>
<td>8—Coal handling equipment</td>
<td>$ 5 to 7</td>
</tr>
<tr>
<td>9—Ash handling equipment</td>
<td>$ 4 to 5</td>
</tr>
<tr>
<td>10—Breeching and chimney</td>
<td>$ 7 to 10</td>
</tr>
<tr>
<td>11—Feed pumps</td>
<td>$ 2 to 3</td>
</tr>
<tr>
<td>12—Piping</td>
<td>$10 to 15</td>
</tr>
<tr>
<td>13—Water treating plant</td>
<td>$ 6 to 9</td>
</tr>
<tr>
<td>14—Motors, wiring and lighting</td>
<td>$ 6 to 8</td>
</tr>
<tr>
<td>15—Combustion control</td>
<td>$ 1 to 3</td>
</tr>
</tbody>
</table>

* Boiler pressures of 250 lb. and less.
† Including unit mills in case of powdered coal.

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Fig. 1—Typical design for the boiler house of a large industrial boiler plant. Silos for the raw coal, with windows between them, form the front wall of the building. Volume of this boiler house, including that of the bunkers, is only 120 cu. ft. per b.hp.
"wide" rather than "high," with economizer and air heater alongside of instead of above the boiler, is more economical, both from the standpoint of building volume and weight of structural steel. This rule does not hold true, however, for the boiler itself. High boilers with a narrow width and with boiler and combustion chamber as a straight block may be very economical to build.

Second, modern coal handling equipment is of such reliability that the size of indoor coal bunkers could be materially reduced. In order to increase the safety factor against interruptions of coal supply to the boiler, it is usually more economical to double the capacity of the coal handling machinery rather than the bunker volume. In other words, the safety should be "kinetic" rather than "potential."

Table II gives data on the building volume, the amount of structural steel and the prices of four modern boiler houses, each of which represents a typical set-up. Although the figures compare favorably with average practice, it will be shown by the following that further appreciable savings are possible.

### Examples of Modern Design

Fig. 1 is a design for the boiler house of a large industrial power plant. The concrete silos for the raw coal stand in front of the 1,600 hp. boilers in such a way that their fronts are fully exposed to daylight, and so that tubes can be easily removed. The silos, with windows between them, form the front wall of the building. They are self-cleaning, which is very important with fine coal, and as they extend down to the mills, large quantities of coal can be stored. The silos are of monolithic structure, and carry the stacks which may be of steel, brick or concrete. Heavy steel columns can be dispensed with. The air heater and the dry and wet gas washers are placed on the roof, separated from the boiler room by a solid ceiling. Thus, dust and sludge will be kept away from the boiler room so that a partitioning wall toward the engine room may be eliminated. The upper story is encased by light sheet metal with wide sliding doors, which provide for good ventilation and which can also be used for removal of fans by means of monorails. With a boiler house width of only 53 ft. and a height of 103 ft., the volume, including the bunkers, is only 120 cu. ft. per b.hp. The savings obtained by this arrangement may be appreciated if one assumes the same plant with conventional parabolic overhead bunkers. In this case, the space requirements will be about 160 cu. ft. per b.hp., and the construction cost is about $27 per b.hp. Of this amount, $15 is attributable to the house itself and about $12 to the bunkers. In the design shown in Fig. 1, 1 cu. ft. of boiler house volume with bunkers and upper story can be built for about $0.18, corresponding to a cost of $21.60 per b.hp. This represents a saving of about 20 per cent of the conventional design. It may be added that the arrangement of Fig. 1 will

<table>
<thead>
<tr>
<th>Type of installation</th>
<th>Cu. ft. building space per 1 b.hp.</th>
<th>Structural steel in lb. per 1 b.hp.</th>
<th>Cost of building and coal bunkers above foundation per 1 cu. ft. building space</th>
<th>Cost of building and coal bunkers above foundation per 1 b.hp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1—Two 512 hp. straight tube boilers—3 unit mills—overhead bunkers</td>
<td>118</td>
<td>197</td>
<td>$0.22</td>
<td>$26.50</td>
</tr>
<tr>
<td>2—Four 600 hp. 4-drum Stirling type boilers—traveling grate stokers—overhead bunkers</td>
<td>158</td>
<td>280</td>
<td>$0.25</td>
<td>$39.30</td>
</tr>
<tr>
<td>3—Six 814 hp. 3-drum Stirling type boilers—traveling grate stokers and blast furnace gas—overhead bunkers</td>
<td>150</td>
<td>270</td>
<td>$0.16</td>
<td>$23.55</td>
</tr>
<tr>
<td>4—Six 912 hp. boilers—economizers—8 unit mills—one traveling grate stoker—overhead bunkers</td>
<td>193</td>
<td>269</td>
<td>$0.17</td>
<td>$31.95</td>
</tr>
</tbody>
</table>
also lend itself to public utility plants with single or double row boiler houses, as it will eliminate the objectionable heavy substructure for the stacks.

An arrangement by which similar savings will be obtained, but which lends itself more to medium sized boiler units of the Stirling type, is shown in Fig. 2. With a width of only 55 ft. and 68 ft. in height, the boiler house contains 750-hp. boilers with economizers and air heaters. The boiler house volume is only 140 cu. ft. per b.h.p., if the bunker volume is included. Yet, because of the inverted position of the boilers with their fronts toward the power house and their firing from the rear, all essential parts are accessible and exposed to natural light. The space above the larry car lends itself to dust catchers of the dry or Cottrell type. The columns for economizers and air heater also carry the stack and induced draft fan. Fans are of the marine type and are placed in the open. This practice has been found quite satisfactory.

As an example of a modern boiler house design for a large steel mill with 1,000-hp. boilers, blast furnace gas and powdered fuel firing, Fig. 3 is offered. The essential features are the same as shown in Fig. 2, except that an overhead bunker of the conventional type has been maintained. By corner firing of gas, the front wall of the combustion chamber is entirely available to the powdered fuel burners. In this way the height of the combustion chamber is reduced considerably. The building space is about 130 cu. ft. per b.h.p. which is, compared with good practice of a few years ago, a saving of 30 per cent in volume and more than $6.50 per b.h.p.

An example of a small plant with two 500-hp. boilers is shown in Fig. 4. Instead of a conventional overhead bunker, a silo on the outside of the plant is used. If the plant had overhead bunkers, the total cost would be about the same, but only half as much coal could be stored as in the case of a silo. Other advantages of a silo are absence of dust and coal gases and better natural lighting of the boiler house. Fig. 4 shows only two mills for two boilers instead of, as is customary, three mills for two boilers. Nevertheless, 100 per cent spare capacity will be obtained, as each motor, mill and its feeder is large enough to take care of two boilers in case of emergency. If one mill should fail, the powdered fuel switch will connect the other mill to both boilers. During such overloads the boiler efficiency will be, of course, rather low.

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**Fig. 3—Example of modern boiler house design for a large steel mill —1000-hp. boilers, blast furnace gas and powdered fuel firing**
The importance of careful planning by designing and constructing engineers cannot be over-emphasized. A careful estimate must be prepared before any detailed designs can be completed. Yet, in the specialties. They act as engineers without a special charge, but are, as a matter of course, not unbiased as far as the selection of parts and material is concerned.

Ordering the various parts is another important point. This requires competent experts who are not only conversant with the engineering side, but who know the market and are absolutely unbiased in their decisions.

Correct scheduling of deliveries and storing of material will avoid expensive delays in the erection, and is a prerequisite for an intelligent schedule of the erection work itself.

All these precautions are common sense but are frequently overlooked. In Europe it has become customary for large firms, such as steel plants, to do most of their designing and construction work by their own engineering force. Capable as it may be, it cannot have the experience of consulting engineers who have specialized in this field. Smaller firms, on the other hand, place their orders with contractors, who are very often identified with manufacturers of boilers, turbines and power plant spes.

This is being mentioned because there is a tendency in this country to follow similar lines. The high standing of American power plant design and construction methods may, to a large degree, be attributed to experienced and commercially unbiased consulting engineers. They are an indispensable link between manufacturers of power plant equipment and its users, and their elimination would be a loss from the standpoint of progressive engineering.

Robert E. Powell Dead

It is with the deepest regret that the publishers of Blast Furnace and Steel Plant announce the death of Robert E. Powell, eastern manager of Steel Publications Inc. Mr. Powell has served as eastern manager of Steel Publications Inc. since its incorporation in 1927. Formerly on the staff of the New York World and of the New York Times, he was thoroughly acquainted with the publishing business and was well known in advertising circles throughout the east. He was a member of the Advertising Club of New York City. Owing to the late receipt of the news of Mr. Powell's death it is impossible to publish a more extended notice.
J-M engineers made these 4 calls...

SACKS-BARLOW FOUNDRIES, INC., Newark, N.J., insulated the arches of three malleable iron annealing furnaces with J-M materials. Fuel costs were reduced 19.6%—to show an annual return on the investment of 114%. The insulation paid for itself in about 10 1/2 months.

... SAVED $663 yearly

WEST VIRGINIA RAIL COMPANY, Huntington, W. Va., insulated their continuous rail furnace with Johns-Manville Superex 2 1/2 inches thick... reduced fuel cost 20.5%... return on investment 119%. Insulation cost $1,740.

... SAVED $2,078 yearly

CHICAGO MALLEABLE CASTINGS COMPANY, N. Pullman, Ill., insulated side walls, base and arch of a 27-foot annealing oven with Johns-Manville materials. Fuel consumption was decreased 26.9%—a saving of 8.17 cents per ton of castings annually. Insulation paid 242% annual return on investment.

... SAVED $836 yearly

OHIO STEEL FOUNDRY COMPANY, Lima, O., insulated regenerator chambers, flues and lower sections of slag pockets of open hearth furnaces with J-M Sil-O-Cel Brick. The saving in fuel oil—280,000 gallons per year—represents an annual return of 418% on the investment. The insulation paid for itself in less than 3 months. It cost $2,763.

... SAVED $11,579 yearly

Can you afford to ignore savings such as these? In every plant, even in those generally considered up-to-date, there are places where insulation will pay big, immediate returns on a comparatively small investment... where heat losses can be eliminated and profit increased for years to come.

- Call in a Johns-Manville engineer. He can show you just where insulation can reduce fuel and power bills—and how much. He knows exactly what insulation will do under given conditions.
- He can determine fuel savings—in advance—with a degree of accuracy that makes J-M Insulation a "sure thing" investment. His visit puts you under no obligation.

Johns-Manville Industrial Insulation

Including J-M Sil-O-Cel, Asbestos-Sponge Felted, Superex, 85% Magnesia, Rock Cork. For all temperatures from 40°F below zero to the highest industrial temperatures.
With the
Equipment Manufacturer

Potentiometer Pyrometer

INTRODUCTION of an improved L & N potentiometer pyrometer has been made by the Leeds & Northrup Company of Philadelphia. The instrument has been given the name of "Micromax" to distinguish it from the preceding L & N potentiometer pyrometer which this company has built for industry since 1910 and of which there are many thousands now in operation. Announcements of this improved instrument describe it as climaxing over 20 years of specialized building of potentiometer pyrometers, combined with 3 years' concentration on the proving of Micromax features.

The manufacturer claims that the L & N Micromax pyrometer constitutes a major contribution to accurate, reliable measurement and control of industrial temperatures. It is more sensitive, more rugged, and is faster in operation. It is fully automatic and eliminates daily attention and adjustments. These advantages are obtained by the new mechanical balancing device, shown in the illustration, and the automatic standardizer, also shown, which checks the instrument circuit every 45 minutes or less. In accordance with the policy of the company, it was desired to protect the many present users of L & N potentiometer pyrometers, and this has been achieved in that L & N recorders now in operation may be equipped with Micromax improvements.

The Micromax balancing device gives micrometer sensitivity, needs no adjustments and is remarkably fast-acting. Owing to the complete elimination of operating clearance between galvanometer pointer and levelers, pointer deflections as small as 1/1000 of an inch can be detected and recorded. Because of this ability of the balancing device to detect extremely small pointer movements, Micromax gives greater sensitivity with greater ruggedness. The recording pen can step across the entire 9/16 in. of calibrated chart in less than 22 seconds, the size of each step being far more closely related to the extent of pointer deflection. The non-slip driving clutch for the pen is direct and simple, and is automatically prevented from attempting to move the pen beyond either end of the scale.

The automatic standardizer is a simple device which automatically checks the potentiometer circuit every 45 minutes or less, giving a much closer adjustment than is obtained by hand. Also, the circuit can be standardized at will (as after changing a thermocouple, when a check is desired) before the 45-minute cycle is completed. By means of the automatic standardizing, the machine itself assures potentiometer accuracy, and the memory of an operator need not be depended upon.

All indicating, recording and controlling models are available immediately. A new catalog describing the L & N Micromax Pyrometer in full detail has been issued, and will be sent upon request to Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia.

Any Speed with New Electro-Hydraulic Transmission

THE American Engineering Company, Philadelphia, Pa., announces the introduction of a small, very compact 5-hp. electro-hydraulic transmission. The transmission will develop full rated torque at any speed, whether it be 1 r.p.m. or 1,000 r.p.m. Since the torque is constant the horsepower output varies with the speed of the hydraulic motor. At maximum speed the transmission will develop 5 hp. continuously.

In the illustration the hydraulic motor is at the
left, hydraulic pump next to it in the middle, and electric motor at the right. They are all mounted on a single bed plate reservoir which contains the oil used in the system. The entire transmission, including motor, is only 30 in. long, 14 in. wide and 16 in. high.

The hydraulic pump and motor are of the Hele-Shaw design and are similar in construction except that the motor has a fixed stroke while the stroke of the pump may be varied from minimum to maximum. Pump and motor are multi-cylinderead and handle the fluid in a smooth, continuous stream.

The electric motor drives the pump shaft at a constant speed. Oil is delivered by the pump to the hydraulic motor at a rate corresponding to the stroke of the pump, regulated by the hand wheel shown, or any other desirable hand or automatic control. This is the only point of regulation for there are no controls on the electric or hydraulic motors. Through the handwheel the speed of the hydraulic motor can be varied all the way from zero to maximum in either a forward or reverse direction.

The pump end of the electric motor shaft is fitted with a fan. Oil in the system passes through finned tubing surrounding the fan, consequently its temperature is maintained at a degree commensurate with efficient operation.

**Mechanical Carloader**

A CARLOADER, designed to operate in conjunction with an existing wareroom loading crane and capable of locating loads up to four tons in any part of a standard boxcar, has been developed and is being marketed by The Wean Engineering Company, Inc., of Warren, Ohio, under exclusive licenses.

The machine is intended for use in conjunction with a 10-ton crane, the loader proper weighing approximately six tons when developed to support a 10-ton load. The machine is suspended from a standard crane hook and may be disengaged in a few seconds when the crane is required for service other than carloading.

A novel feature of the design makes possible perfect balance of the loader proper whether loaded or hanging free. This feature is accomplished by balancing the loader itself as well as locating the load on the center of gravity of the crane hook.

By varying the type of loading grab hook used, an infinite variety of material up to 4,000 lb. can be spotted at any point within the boxcar area. The time required to load the average car, will, of course, depend upon the material and the weight of each lift. In loading steel sheets, one crанeman and one hooker can load a 50-ton car in less than 30 minutes.

Aside from the savings in time and labor made possible by the apparatus, an appreciable saving is also effected where sheets or like material subject to scratching when handled singly are loaded in strapped bundles.

**Heavy Duty Contactor**

A RADICALLY new heavy duty contactor for steel mill, crane and general purpose d.c. magnetic controllers has been developed by the Westinghouse Electric & Mfg. Company. These contactors are of unique construction, are compact and may be mounted very closely together since all parts are removed from the front for replacement.

A highly effective rupturing capacity is obtained by a new high speed operation and especially designed arc box and horns along which the high flux blowout forces the arc. The fast opening of contacts assists in the rapid extinction of the arc, thus prolonging the life of contact tips, are box and other adjacent parts.
SAFETY FIRST IN THE STEEL PLANT

Bethlehem Safety Instructor Dies

Edward A. Yellis, 55, safety instructor, Bethlehem Steel Company, Bethlehem, Pa., died August 26 in a Philadelphia hospital. He was a graduate of Lehigh University and prior to entering Bethlehem employ, was a member of the faculty of the Moravian Preparatory School.

Foundries Seek Lower Insurance

Seeking a lower insurance rate by reducing accidents the Ohio Foundries Association will launch a six-month safety campaign in nearly 600 Ohio foundries October 1, according to Robert Hoierman, secretary.

Plans for the campaign were outlined shortly after the Ohio Industrial Commission announced a deficit of $706,796 in four of the foundry classifications and increased the rates for the iron foundries and the non-ferrous classification 25 and 33-1/3 per cent respectively, in an effort to reduce this deficit by nearly $500,000. Steel and malleable iron rates were not increased, although these two classifications showed a deficit of $230,992.

General chairman for the campaign is A. H. Kramer, president, Advance Foundry Company, Dayton, Ohio, and J. W. Beall, insurance commissioner, Ohio Steel Foundry Company, Lima, Ohio, is assistant general chairman.

Safety Congress has Wide Appeal

Hundreds of representatives of the metal industries of the country will meet at the Stevens Hotel in Chicago, October 12 to 16, for practical ways to reduce accidents and accident causes as a part of the twentieth annual safety congress and exposition. This is sponsored by the National Safety Council.

The accident prevention program will be conducted by three groups of the Safety Council—the metals section, the automotive and machine shop section, and the power press section, representing about 1700 industrial organizations which employ between 2,000,000 and 3,000,000. These organizations include about one-third of the total membership of the National Safety Council.

The metal industries are reported to have been making decidedly encouraging progress in accident prevention. Seventy-three establishments that have been reporting to the National Safety Council show a decline of 39 per cent in their accident frequency rates and 15 per cent in their accident severity rates in the last three years. The accident frequency rate for the entire group is 35 per cent below the average for all industries, but the accident severity rate is 25 per cent higher than for all industries. These reports also show that the larger steel plants have accident frequency rates less than one-third the average rate for smaller steel plants.

The accident rates of the foundry industry are somewhat less favorable. The average accident frequency rate for the 138 establishments which reported to the National Safety Council for 1930 was nearly three times as great as the frequency rate for the steel industry, and the accident severity rate was considerably higher.

The automobile industry has shown especially good progress in accident prevention. The 1930 frequency rate for 129 establishments was 41 per cent below the 1928 rate and 43 per cent below the 1929 rate. In the railway car and equipment industry group the accident experience was less favorable. Twenty-eight establishments had an accident frequency rate somewhat higher than for 1928, though considerably less than for 1929. The severity rate of these 45 establishments was nearly five times as great as for the year 1929.

In the machinery industry, 141 establishments which have been reporting for the past three years show a 14 per cent decline in accident frequency rates.
TRADE NOTES

The Otis Steel Company of Cleveland, Ohio, has purchased from H. A. Brassert & Company of Chicago a 12-in. 60-mesh Burrell Automatic Strainer for cleaning the water to be used at the spray nozzles on their new 72-in. four-high strip mill.

* * *

The Farrel-Birmingham Company, Inc., of Ansonia, Conn., has opened a new office in Chicago, 1059 First National Bank Building, Monroe and Clark Streets. The office is in charge of Harry Temporal, who was transferred from the Akron office. Mr. Temporal has been a sales representative of the company for 21 years, having first joined the Farrel Foundry & Machine Company at Ansonia in 1910. In 1922 he was transferred to the Cleveland office and in 1928 to the Akron office when the two offices were consolidated. The Akron office, in charge of Andrew Hale, has been removed from the United Building to 2710 Central Depositors Bank Building.

* * *

The Page Steel & Wire Company is opening a southeastern district sales office with headquarters at 1520 Healey Building, Atlanta, Ga. This new office will be in charge of R. J. Teeple, who will have charge of distribution of all Page products in the southeastern district. These products will include various types of woven wire fence, wrought iron fence, welding wire, highway guard and general wire products. Mr. Teeple has been connected with the fence department of the Page Steel & Wire Company for the past 10 years, and has been in charge of the chain link fence division for the past three years. The Page Company is an associate of the American Chain Company, Inc., Bridgeport, Conn.

* * *

Announcement has come from the general offices of the International-Stacey Corporation, Columbus, Ohio, that B. T. Ehrman, who was formerly located in the Chicago office of the International-Stacey Corporation, has been transferred to St. Louis as division manager with offices at Room 2192, Railway Exchange Building.

* * *

At the last meeting of the board of directors of the Johns-Manville Sales Corporation, T. K. Mial, R. C. Harden, G. R. Lewis, J. M. Taylor and Franklin Shuey were elected vice president, to have executive supervision of various territorial districts.

The districts for which these executives will be responsible are as follows: T. K. Mial, Metropolitan, Boston, Philadelphia and New York; R. C. Harden, Chicago, St. Louis, Northwestern and Denver; G. R. Lewis, Cleveland, Detroit, Pittsburgh and Cincinnati; J. M. Taylor, New Orleans, Atlanta and Houston; Franklin Shuey, San Francisco, Los Angeles and Seattle.

The managers of the districts are as follows: Metropolitan, E. W. Heurung; Philadelphia, J. O. Boylan; Boston, G. W. Esler, Jr.; New York State, G. R. Frankland; Cleveland, E. Dowling; Detroit, E. F. Boyle; Cincinnati, H. L. Steiner; Pittsburgh, E. W. Rosenberger; Northwestern, W. G. Wendland; Chicago, W. H. Fogarty; St. Louis, T. C. Greenwood; Denver, L. H. Inglee; Atlanta, J. H. Olden; Houston, T. E. Gossett; New Orleans, C. J. Flanagan; San Francisco, E. H. Clausen; Los Angeles, H. B. Heyn; Seattle, F. W. McDermott.

* * *

C. W. Traughber has been appointed as technical and metallurgical adviser of the Northern Blower Company. Mr. Traughber comes to the Northern Blower Company after an association with Anaconda Copper Company, American Smelting & Refining Company, and other large smelting plants, for many years. His long experience and knowledge of fumes, gases, fly ash and general dust problems, will be invaluable to the trade and to the further efficiency of the company.

* * *

W. C. Bruton, for many years sales engineer of the American Manganese Steel Company working from the Oakland, Calif., office, has been appointed district sales manager for the Pacific Northwest territory, comprising Oregon, Washington, British Columbia and the Coeur D'Alene district in Idaho. Working with Mr. Bruton in the sale of Amsco products are the agency representatives, P. R. Hines, Lewis Building, Portland, Ore. and Paragon Supplies, Ltd., 845 Hastings Street, East Vancouver, B. C., Canada, who have been connected with the company for years.

* * *

The Lakewood Engineering Company has sold the industrial division of its business to the Easton Car & Construction Company, Easton, Pa. Hereafter the complete line of Lakewood tier trucks, electric trucks, trailers, skids and industrial cars will be manufactured at Easton, Pa. This consolidation rounds out the Easton line of cars and trucks and makes it possible for the company to supply practically every industrial car or truck requirement.

* * *

Aetna-Standard Engineering Company, Youngstown, Ohio, recently has acquired control of United States letters patent granted to Lawrence C. Steele, covering an improved method of manufacturing metal sheets. The Steele patent covers the method or process of these operations. The Steele method eliminates by mechanical means the grueling labor of the old method by conveying the heated bars or sheets from the furnace to the mill, feeding and catching the metal at the mill during the rolling process, doubling and returning the packs to the furnace for reheating. By this method, far greater
production is obtained at a greatly reduced cost without jeopardizing the quality of the finished product. Aetna-Standard also owns licenses upon mechanical catchers and other equipment under detail patents granted to the late Arthur R. McArthur.

**“Hardtem” Razor Blades**

SEVERAL years ago, June of 1929, to be exact, the salesmen of a fairly prominent die block, forging, and shear knife manufacturer (name on request) were in convention midst the mountains of Center County, Pennsylvania. As was his custom, the sales manager of this organization was shaving one morning and, as the “safety” razor pulled and tore its merciless, devastating path through a day’s growth of stubble, laying bare the agonized flesh beneath, he groaned to a fellow-executive standing by:

“We’ve been talking about ‘diversification of product’—why the devil can’t we put out a decent razor blade?”

The plea for mercy, of a tortured man, proved to be “the berth of an idea.” For the company took up the task with gusto, and immediately commenced looking about the plant for some basis, or foundation, upon which they might develop and, eventually produce, a razor blade steel to meet the standards of their hypothetical ideal.

If you will pardon our shift to the personal—we were much encouraged by the realization that we had in our possession two important elements conducive to the ultimate realization of our “dream.” First, was a steel which we believed wonderfully suited to our purpose; and second, a furnace in which to make this steel, for we realized that it must be extraordinarily clean and fine.

During the preceding year, we had introduced to the sheet and tin plate industry a shear knife which immediately set new standards in the shearing of those products. This shear blade was titled “Kleenkut,” and it was unconditionally guaranteed to give four times the service of any plain carbon knife on the market. We were never forced to retract our guarantee, for the knives continuously give from eight to ten times the service. This, then, was our steel, and after some modification to adapt it to the extensive hot rolling and cold drawing, which it would undergo, we called it “EIS” 45 and the analysis was patented in the U. S. Patent Office.

In the fall of 1928, we had also pioneered, in this country, with the introduction of the electric induction method of steel melting. While this type furnace produces but 600 lb. at a charge, at the same time, the steel produced has no superior in the industry today, in regard to cleanliness, quality, and adherence to specification. We had been manufacturing our Kleenkut analysis in the electric induction furnace for over a year with unusual success, so that we were familiar with the steel and were ready to proceed.

Accordingly, several ingots were cast, forged under the steam hammer to convenient size, machined all over to remove the scale and decarbonized area, and finally hot rolled and cold drawn into razor blade strip .006 in. in thickness. The strip was then processed into razor blades and we were all set to put our theories to test.

Blades were furnished to a group of 150 men with the request that they be used, without stropping or honing, until they failed to give a clean, comfortable shave. The result was not only a satisfactory report on the part of the users, but repeated requests for more blades of the same quality. For they had consistently given between three and four times the service which the shaver was accustomed to expect from the ordinary blade.

We were, of course, much encouraged, and continued with repeated trials and experiments to prove to ourselves that we really had the blade for which we were seeking. Every trial, however, bore out our first finding—that we had “something better.” Having now the confidence and respect of our own organization, we felt that our secret should no longer be withheld from the public.

So at the National Metal Exposition held in Boston September 21, the Heppenstall Company introduced for the first time their “Hardtem” razor blade. And it is particularly fitting that it be announced at a steel convention, for “Hardtem” is the first blade in this country to be produced and marketed by a steel manufacturer.

We have labored long, to produce a finer razor blade, and we await with a great deal of anxiety, mixed with faith, the placing of the public's stamp of approval on our new product. If we are fortunate enough to win this approbation, we will be gratified in knowing that we have played a small part in making more pleasant the daily life of Mr. Average Citizen.
PUBLICATIONS

The Mine Safety Appliances Company, Braddock Avenue and Thomas Boulevard, Pittsburgh, Pa., has issued catalogue No. FA-2. This publication, which consists of 35 pages, gives price lists, illustrations and descriptive matter concerning the complete line of first-aid materials and supplies manufactured by the company.

A four-page leaflet describing a new mill motor has recently been announced by the Westinghouse Electric & Mfg. Company. This new motor embodies the latest recommendations of the Association of Iron and Steel Electrical Engineers.

The application of the motor includes heavy duty operations such as steel mill auxiliary drives, cranes, hoists, shovels, coal and ore bridges, mine hoists, railway turn tables, transfer tables, railway lift bridges, traffic bridges, conveyors, etc.

Copies of this leaflet, No. 20525, may be obtained from the nearest district office or direct from the advertising department, Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.

William M. Bailey Company, Magee Building, Pittsburgh, Pa., features a thermal expansion goggle valve in a recently issued 6-page booklet. This publication gives diagrams of the equipment, together with photographs of typical installations on blast furnace and boiler plant gas mains. In addition, there is described and illustrated a sintering plant pug mill marketed by the company.

COMING MEETINGS


Oct. 14-16—Society of Industrial Engineers. Annual meeting to be held in Pittsburgh. Secretary, George C. Dent, 205 W. Wacker Drive, Chicago.

Oct. 15-16—Gray Iron Institute Inc. Fourth annual meeting to be held at West Baden Springs Hotel, West Baden Springs, Ind. Manager, Arthur J. Tuscany, Terminal Tower, Cleveland.


Nov. 30-Dec. 5—American Society of Mechanical Engineers. Annual meeting to be held at Engineer Societies Building, New York. Secretary, Calvin W. Rice, 29 West Thirty-ninth Street, New York.

Forging Quality Steels

(Continued from page 1352)

samples are carburized at 1700 deg. F. for 8 hours and after slow cooling (this rate of cooling depending upon the type of steel being tested—for 5 percent nickel steel about 15 deg. per hour), sections are cut. It is imperative that rating be taken on a cut or sawed face and not on a scaled surface. The specimens are polished for microscopic examination, etched in Nital and rated at 100X. At the present time there are several charts brought out by the various steel companies which are used as standards. This test has its proper place and should be specified only where the processes involved and results required necessitate a fine or coarse grained steel. It is not a panacea for all ills or troubles.

Along with the deep etch test and microscopic examination, the disc fracture test is sometimes specified. (This should not be confused with a notch fracture test which is used to inspect for pipe and consists simply of notching a bar or billet and fracturing. This is an excellent method of inspecting for pipe.) This consists of cutting thin discs from the ends of the bars and hardening them as hard as possible by water quenching. They are then broken and the fractures inspected for discontinuities in the material. This type of test is usually applied to high carbon tool steel and high carbon-chrome bearing steels.

Closely associated with the disc fracture test is the hardenability test which is performed by cutting discs of various thickesses and determining the maximum thickness which hardens throughout the cross-section. One disc stepped down to various thicknesses can be used. In making this test definite quenching conditions must be established and maintained. This test is only used on high carbon steel.

In many cases where these tests are specified they are made in the steel mill as a matter of record before the steel is shipped so that the mill knows that the material shipped properly meets the specifications. This necessarily throws a great deal of testing onto the metallurgical laboratories of the various steel plants. It also necessitates a closer contact between the customers’ engineering and metallurgical departments and the steel mill metallurgist. The mill representative takes the information back to the operating department so that the proper quality can be produced. By such close cooperation the forge shop (and their customers) are receiving steel of more uniform characteristics and better quality.
Properties of the Tulsa Rolling Mills Company with blooming, billet and bar mills at Sand Springs, Okla., were offered for sale at public auction September 15. It is understood L. W. Conroy, formerly with the United States Steel Corporation withdrew as second vice president several months ago.

Mr. Conroy, it is understood, is associated with William Ungerman, iron and steel scrap dealer of Tulsa, in projecting a mill at Dallas, Texas, to reroll rails and scrap. He has offices in the Republic National Bank Building, Dallas.

The Tulsa Rolling Mills Company was incorporated March 19, 1928, in Delaware. The company authorized the issuance of 10,000 shares of no par common stock of which 9,662 shares actually were issued; and also authorized $600,000 in 7 per cent cumulative preferred shares, of which $380,400 actually were issued; besides $200,000 in bonds.

The company in 1928-29 built rolling mills at Sand Springs near this city and put them into operation in July, 1929. These consisted of one basic open-hearth furnace of 100-tons capacity, using fuel oil; two continuous oil-fired heating furnaces; a 24-in. 3-high blooming mill, a 16-in. 3-high billet mill, and a 10-in. 3-high guide mill. Its annual capacity was estimated at 60,000 tons of steel ingots, 50,000 tons of blooms and billets, or 45,000 tons of merchant and concrete bars.

The officers of the Tulsa Rolling Mills Company originally were: President, J. H. McAlarney; secretary, C. A. Coakley; treasurer, C. F. Tingley and general sales manager H. B. Bevan, all at Tulsa; and first vice president E. M. Monsell, second vice president L. W. Conroy and purchasing agent W. C. McCarthy, all at Sand Springs.

* * *

Mullins Manufacturing Company, specializing in the manufacture of steel boats, has started production on orders for automotive parts received from two of the largest auto companies in the country, these aggregating a value of $1,000,000.

* * *

American Bridge Company, subsidiary of the United States Steel Corporation, has been awarded the contract for 48,000 tons of structural steel to be used in the new Chicago post office. Fabrication of the steel will give full-time employment to about 1000 men for a period of from four to six months.

* * *

Negotiations are reported going on in Montreal between the American Manganese Steel Company of Chicago, the City of Montreal and J. B. Baillargeon, industrial commissioner for Montreal, regarding plans of the United States Steel Corporation to erect a foundry and plant in Montreal. Unofficially, it is stated that the company proposes to erect a $2,000,000 plant in the eastern part of the city on the banks of the St. Lawrence river.

Officials of the company were in Montreal and were assured that the city will assist in every way possible in regard to acquisition of suitable land, arrangements for water and electric power, transportation, etc.

The company will manufacture manganese steel castings, machinery and machinery parts, as well as heat and corrosion resisting castings. A site on the banks of the St. Lawrence will be chosen in order to facilitate the unloading of manganese ore, which will be obtained from mines in South Africa.

* * *

The Inland Steel Company has received an order from the Wisconsin State Board of Control for 400 tons of sheets for delivery to the automobile license tag shop of the Wisconsin state prison at Waupun. The entire supply of auto tags for the state is manufactured at the prison and about 200 tons additional will be purchased later.

* * *

Formal organization of the American Institute of Bolt, Nut and Rivet Manufacturers at New York recently, has been made known. George S. Case, president of the Lamson & Sessions Company of Cleveland, is president of the new organization. Approximately 70 to 75 per cent of the productive capacity of the industry is affiliated, it is said.

A meeting of the organization is scheduled to be held at which time questions regarding the appointment of a permanent secretary and the location of general headquarters, in all likelihood, will be decided.

* * *

Aetna Standard mill of the American Sheet & Tin Plate Company at Bridgeport, Ohio, is being dismantled and will be abandoned. It has been idle since May 27.

The mill was established in 1873 as the Aetna Iron Works and in 1900 became part of the American Sheet & Tin Plate Company. At one time 23 sheet mills were in operation but in 1917, 17 were dismantled. At the time of the shut down only a plate mill and a jobbing mill were in operation.

* * *

The new rod mill unit of the plant of the Canada Wire & Cable, Ltd., Montreal, Que., has been completed and is being operated.

* * *

Bethlehem Steel Company, Bethlehem, Pa., has formally announced the acquisition of the Kalman Steel Company, Chicago, fabricator and distributor of reinforcing steel, concrete accessories, wire fabric, steel joists and frames, and metal lath. The acquired company is to be known as the Kalman Steel Corporation, offices at Bethlehem, Pa.
INGOTS LIKE THIS . . .

• A 19 x 22 x 85" ingot from a .14 carbon heat for seamless tubing (analysis of drillings upon request).

• Ingots like the one pictured are the regular day-in-and-day-out practice at plants using Gathmann big-end-up molds—an average bloom yield of 84% of sound steel.

• Blooms of any specification are sounder and freer of surface seams and blisters for having been produced from big-end-up ingots.

• With the new method of stripping big-end-up ingots now being introduced, sinkhead and non-sinkhead ingots can be produced and delivered to the mill at less cost per ton than has been possible heretofore.

• Investigate the possibilities of this improved Gathmann method in your practice. We shall be glad to answer your inquiries.

THE

GATHMANN

ENGINEERING COMPANY

"DESIGNERS OF INGOT MOLDS SINCE 1909"

Baltimore, Maryland
News of the Plants

The Kalman Corporation will have the following as general officers with headquarters in Bethlehem: Paul Mackall, president; George E. Routh, Jr., vice president in charge of sales; Quincy Bent, vice president in charge of operations; R. E. McMath, vice president and secretary; Robert Young, treasurer; F. A. Shick, comptroller; and Charles R. Holton, purchasing agent.

Virtually the entire selling organization of the Kalman Company is retained under the direction of Mr. Routh. A. P. Clark continues with the company as general manager of sales.

Where economy and efficiency can be obtained through combining with office space of other Bethlehem subsidiaries, district sales office addresses will be adjusted in the near future.

Aetna-Standard Engineering Company, Youngstown, Ohio, builder of rolling mill machinery, plans to increase production at its plant at Ellwood City, Pa., and is recalling several hundred workmen on account of the enlarged operating schedule.

Colorado Fuel & Iron Company, Denver and Pueblo, Colo., has decided to continue the operation of a blast furnace stack at its Minnequa plant at Pueblo despite the fact that its output is not actually required at this time. This will necessitate reopening limestone quarries, continue in operation coke ovens which would have been discontinued, and reopening the iron ore mine at Sunrise, Wyo.

St. Joseph Steel Alloys Company, St. Joseph, Mich., has been formed with a capitalization of $125,000 to take over the plant of the former St. Joseph Electric Steel Castings Company. The proposed industry would produce stainless steel castings. Frank Hatfield, purchaser of the St. Joseph Electric Steel Castings Company equipment, is interested.

Dow Chemical Company, Midland, Mich., has announced plans for a rolling mill and fabricating plant for Dowmetal or magnesium sheets. The mill will be erected on the site of the old No. 1 building at Midland, which is already being torn down. The structure will be of brick and steel construction 100 x 160 ft. and will contain approximately 20,000 sq. ft. of floor space. Equipment will consist of the rolling mill to be supplied by a Pittsburgh district builder, which will roll material up to 60 in. wide; a straightening machine, heat treating furnaces, etc.

Bethlehem Steel Corporation is moving its offices at Philadelphia from the Widener Building to the Broad Street Station Building about October 1. Offices of its subsidiaries, the McClintic-Marshall Corporation, now in the Morris Building, and the Kalman Steel Corporation, now at 1608 Walnut Street, will also be moved to quarters adjoining the parent company.

Wellman Engineering Company, Cleveland, has been awarded the contract for a mooring mast for dirigible aircraft for the navy department, to cost $119,000. It is to be delivered at Lakehurst, N. J., in about seven months for installation and tests and then sent to the new dirigible base to be constructed at Sunnyvale, Calif. It is designed for use on standard railroad tracks, similar to one recently delivered at Lakehurst, with added features.

Meeting of the American Iron and Steel Institute

The fortieth general meeting of the American Iron and Steel Institute will be held at the Hotel Commodore, New York City, on Friday, October 23. There will be the usual sessions, morning and afternoon, at which technical papers will be read. This will be followed by a banquet in the evening.

American Institute of Steel Construction to Hold Convention

Local as well as national problems in the field of steel construction will be given consideration at the ninth annual convention of the American Institute of Steel Construction, which will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., October 28 to 30 inclusive. The general conferences to be held morning and afternoon will be given over entirely to the usual formal addresses and discussions of national problems of the industry. At luncheon and dinner the membership will be divided into local groups according to geographical divisions so that they can review more intimately the problems which are specific to themselves.

The convention will this year consume but three days instead of the full week heretofore devoted to the annual gathering. The chief social event, the annual banquet, will be held on Thursday night as usual. On the whole the time will be devoted more intimately to the problems of the industry, a review of conditions of the past year and an exchange of views on how steel construction can be advanced. The discussions will be divided equally between the technical problems of production and the economic problems of selling. All the formal speeches of the convention will be made by persons drawn from the industry, no outside talent being enlisted upon this occasion.
TELETYPEWRITER SERVICE

PROVES INVALUABLE TO EVERY DEPARTMENT
OF THE COOPER-BESSEMER CORPORATION

Striking evidence of the importance of Teletypewriter Service* to every department of an organization is found in statements by officials of The Cooper-Bessemer Corporation, builders of gas and diesel engines. The service gives constant typewritten communication between plants at Mt. Vernon, Ohio, and Grove City, Pennsylvania.

Secretary in Charge of Production: "Invaluable. In planning production for the two plants, it does not make any difference at which end of the line we happen to be. We are in instant communication with all departments."

General Purchasing Agent: "With our two plants 170 miles apart, we have been able to centralize our Accounting, Purchasing and Research Departments, which would have been impossible otherwise."

Manager of Cost Engineering: "Sold itself to me from the very first by transmitting my data accurately, and making a copy for me in the sending."

Asst. Sales Manager, Mt. Vernon Division: "Saves time. Provides permanent record of great value."

Asst. Sales Manager, Grove City Division: "A prospect calls at one office regarding a product built at another. While he sits at the desk, questions are teletyped and answered. No telling the prospect you will let him know tomorrow. You tell him now."

General Manager, Grove City Plant: "Very useful in giving instructions between plants... ordering blue-prints required on rush jobs... reporting goods received to Purchasing Department, enabling them to take the discount on bills."

Asst. Treasurer: "Great help and time-saver in securing information from the works in regard to their regular monthly statements."

Teletypewriter Service cuts costs and speeds operations for every type of business, large and small, whether the separated divisions are 300 feet or 3000 miles apart. Your local Bell Telephone Company will gladly show you how it could serve your company.

* * *

*Teletypewriters provide direct typewritten communication between separated offices of a business company. A message typed on one machine is identically reproduced at the same moment on all connected machines.
Albert H. Shonkwiler, assistant superintendent of the Otis Steel Company, Cleveland, resigned September 1 to accept a position with the Steubenville works of the Wheeling Steel Corporation.

William A. Irvin has been appointed vice president of the United States Steel Corporation in connection with manufacturing operations, it was announced by President James A. Farrell. This is a newly created post. Heretofore, Mr. Irvin has been vice president of the American Sheet & Tin Plate Company in charge of operations.

D. P. King, has resigned as general superintendent of the Monessen, Pa., plant of Pittsburgh Steel Company, Pittsburgh, because of ill health. He has been identified with the Monessen plant ever since its first operation. No successor as yet has been appointed.

Dr. Harry L. Frevert, recently noted as being elected president of the Midvale Company, Nicttown, Pa., to succeed the late Alva C. Dinkey, has been identified with the steel industry since 1909 when he became chemist for the Midvale Steel Company. A year later he was appointed chief chemist and remained in that position for two years. In 1915 he became superintendent of the armor plant of the Midvale Company, and in 1917, superintendent, in general charge of metallurgical treatment.

Four years later he became general superintendent and in 1923 vice president of what is now the Midvale Company. He held this position until his recent appointment.

Charles P. Mills, recently director of the chrome alloy department of the General Alloy Company, has resigned to take the position of chief engineer of the Empire Steel Castings, Inc., Reading, Pa. Mr. Mills is one of the leading authorities on heat and corrosion resisting Chrome Iron and Chrome Nickel castings in the country, and was for many years chief engineer of the Duraloy Company of Pittsburgh. He is a graduate of the engineering department of the University of Pennsylvania, and spent four years in the Panama Canal, after which he was associated with the Fort Pitt Bridge Company of Pittsburgh as designing and sales engineer. He first became interested in alloys in 1921 and has actively followed this line to the present time. He is a member of the American Institute of Mining and Metallurgical Engineers, American Petroleum Institute and the Engineers' Society of Western Pennsylvania.

Trusten P. Draper has retired as vice-president in charge of operations of Sharon Steel Hoop Company, Sharon, Pa., after having been connected with the company for many years. It is likely that his work will be divided among other executives, under direction of John A. Roemer, president.

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Four years later he became general superintendent and in 1923 vice president of what is now the Midvale Company. He held this position until his recent appointment.

* * *

Charles P. Mills, recently director of the chrome alloy department of the General Alloy Company, has resigned to take the position of chief engineer of the Empire Steel Castings, Inc., Reading, Pa. Mr. Mills is one of the leading authorities on heat and corrosion resisting Chrome Iron and Chrome Nickel castings in the country, and was for many years chief engineer of the Duraloy Company of Pittsburgh. He is a graduate of the engineering department of the University of Pennsylvania, and spent four years in the Panama Canal, after which he was associated with the Fort Pitt Bridge Company of Pittsburgh as designing and sales engineer. He first became interested in alloys in 1921 and has actively followed this line to the present time. He is a member of the American Institute of Mining and Metallurgical Engineers, American Petroleum Institute and the Engineers' Society of Western Pennsylvania.

* * *

Trusten P. Draper has retired as vice-president in charge of operations of Sharon Steel Hoop Company, Sharon, Pa., after having been connected with the company for many years. It is likely that his work will be divided among other executives, under direction of John A. Roemer, president.
A Two Million Dollar Steel Plant

Goes Under Auctioneers’ Hammer

Tuesday, October 20, 1931, at 9:30 A. M.

We will sell at

Absolute Public Auction Sale

The contents of

PENN SEABOARD STEEL CORPORATION

On Premises—NEW CASTLE, DELAWARE

(4 Miles From Wilmington, Delaware)

A Modern Fully Electrified Rolling Mill

of 150,000 Ton Yearly Capacity

MILL EQUIPMENT: 84” x 34” National Roll & Foundry Blooming Mill, complete with 2100 H.P. Reversing Motor, 0-120 R.P.M., D.C., 700 volts, panels and controls; 1600 K.W. Westinghouse Motor Generator Set, D.C., 700 volts, and controls; 8” x 8” Billet Shear with motor; 16” United Engineering Roughing Mill, 3 high, 3 stands, 800 H.P., A.C. Motor and Falk Reduction Gear; 13” United Engineering Finishing Mill, 6 stands, 3 high; 12” United Engineering Roughing Mill, 4 stands, 3 high, Farrell Reducing Gear, Continuous Heating Furnaces with Air Pushers 11 ft. x 40 ft. oil fired; Hot Beds and Stretchers; 5” United Engineering Billet Shear and motor; 1,000 K.W. Synchronous Converter, D.C., 230 volts; 2200 cu. ft. Compressor with 400 H.P. Synchronous Motor, A.C., 60 cycle, 2200 volts; No 4 Doelger & Kirsten Alligator Shear; Assorted Overhead Electric Cranes from 5 ton to 25 ton, 65 ft. span, D.C., 230 volts.

COMPLETE MACHINE SHOP: Lathes, Planers, Drills, Shapers, Roll Turning Lathes, Hot and Cold Saws.

ELECTRIC MOTORS: D.C. and A.C., 5 to 800 H.P., Transformers 165 to 1,000 K.V.A.

OPEN HEARTH EQUIPMENT: 150-ton Open Hearths; 3½-ton Morgan Horizontal Charger; 10-35-ton Bottom Pour Ladles; Soaking Pits, gas and oil fired; Locomotives and Cranes.

COMPLETE PATTERN SHOP: Engineering and Office Equipment; and other items too numerous to mention.

Send for Descriptive Circular

PLANT OPEN FOR INSPECTION

Sale under management of

Industrial Plants Corporation

AUCTIONEERS
25 Church Street

APPRAISERS
New York, N.Y.
Dr. Frevert was born in Dayton, Ohio, June 21, 1881. He was graduated from Harvard University in 1905 with an A.B. degree of high distinction, and three years later with a degree of doctor of philosophy. He was an Austin Teaching Fellow in physical chemistry at Harvard 1904-1905, and was instructor in that department, 1905-1909.

Otto Nonnenbruch, for the past four years chief engineer of the Diesel department of I. P. Morris and De La Vergne, Inc., Philadelphia, Pa., and previously with Worthington in various capacities for nine years, rejoined the latter organization as of July 1.

Willi Dienenthal, Dango & Dienenthal, Siegen, Germany, German Associate of Edgar E. Brosius Inc., Pittsburgh, designer and manufacturer of steel plant equipment, has spent several weeks in the United States.

John P. Sykes, vice president of the Baldwin Locomotive Works, Philadelphia, has been elected a director of the company to fill the vacancy occasioned by the death of Alva C. Dinkey.

Lloyd Jones, manager of the Salem, Ohio, works of E. W. Bliss Company, Brooklyn, N. Y., rolling mill equipment builders, sailed recently for Europe on a business trip.

H. E. Chilcoat has been appointed general sales manager of the Koppel Industrial Car & Equipment Company, Koppel, Pa. Mr. Chilcoat, who was formerly sales manager of the air dump car department of that company, has had a long experience in selling material handling equipment to the contractor, railroad, industrial and quarry fields.

C. B. Coldwell who was formerly located in Chicago has been transferred to the Ft. Worth office of the International-Stacey Corporation. He has been placed in charge of the sales of the Roots-Connersville, Wilbraham Division line of R-C-W rotary positive blowers, meters, gas pumps and exhausters.

Lawrence Carr Steele formerly consulting experimental engineer, is now affiliated with The Aetna-Standard Engineering Company, Youngstown, Ohio, as consulting engineer on sheet and tin plate equipment. His headquarters are in the general offices of the company at Youngstown.

Mr. Steele was born in West Virginia and finished his college education in Virginia. He entered the employ of the old American Tin Plate Company as master mechanic and about 1903 was made district engineer of the plants of The American Sheet & Tin Plate Company in the Wheeling district. About the year 1910 he entered the employ of the Jones & Laughlin Steel Corporation, in charge of the installation of its tin plate plant at Aliquippa, following which he opened his own office in the Oliver Building, Pittsburgh, as consulting and designing engineer.

During the years 1922 to 1926 he was connected with the Bethlehem Steel Company at Sparrows Point, Md.
Gas... Uniform High Quality

Steady Flow... at Low Cost

The new WOOD type S-B continuous automatic Gas Producer has proved its advantages. • • The new patented WOOD Coal Feeder is the only apparatus on the market which provides an even distribution of coal over the entire fuel bed. • • Further, the water-sealed construction makes and keeps it absolutely gas tight, and reduces wear to the lowest possible minimum. • • When desired, it is equipped with a mechanical control which automatically regulates the discharge to suit prevailing load conditions. • • Write for complete information; arrange to visit an installation.

WOOD & COMPANY
PHILADELPHIA

Designers and Builders of Mechanical Gas Producers since 1889
Sheet and Tinplate Rolls*

By J. Selwyn Caswell
M.Sc., A.M.I.Mech.E.

It is probable that there will be nothing new in the conclusions which have been drawn from the returns, because they are merely a paper record of what has been gradually formed in the minds of those men who have spent many years in the trade.

The particular purpose which the writer had in view was to determine the relationship between the records and the stress conditions set up in the rolls.

The conclusions which are suggested by the returns are as follows:

Conclusions Regarding the Occurrence of Roll Breakages

1—For tinplate mills, the ratio:

Number of rolls broken annually

Number of mills

= approximately 1.8;

and in the case of sheet mills the value of the ratio is 4.0.

According to Ryland’s Directory (1926), there are 390 sheet mills and 515 tinplate mills in this country, and if it is assumed that 65 per cent of these are continuously at work, the total number of rolls broken annually for the whole of the sheet and tinplate trade in this country is 1600 approximately, of which 1000 are sheet mill rolls and 600 are tinplate mill rolls.

2—A greater number of rolls are broken during the winter months than during the summer months.

3—Most of the rolls are broken during the three days, Tuesday, Wednesday and Thursday, and the greatest number of rolls are broken on Tuesday.

4—There is little difference between the number of rolls broken on each shift.

5—There appears to be no part of any shift at which the liability to roll breakage is greater than at any other part of the shift.

6—There is some evidence pointing to the view that roll breakages are more frequent with large diameter rolls.

7—The average life of a tinplate roll appears to depend more on the life of the chill than on the occurrence of breakage, and worn finishing rolls are used for considerable periods in the roughing mills. The average life, as given by returns, is 16 weeks.

8—It appears that the life of sheet mill rolls depends mainly on the occurrence of breakage, and the returns indicate that the working life of these rolls averages 10 weeks.

9—The greatest number of rolls are broken on the “parts” shown below:

Sheet Mills (in which the same pair of rolls is used for roughing and finishing). Thick iron, “fours” (matching fours), “sixes” and matching of “sixes.”

Tinplate Mills (separate mills for roughing and finishing). “Singles,” “fours” and “eights.”

10—Eighty-three per cent of the rolls were broken on first runs.

11—Thirty-four per cent of the rolls were broken during the first run on matching of the pieces, and nearly the whole of these breakages occurred on the matching of the thick iron, “fours” and “sixes” in the sheet mills.

12—The last two conclusions suggest that modification, or more stringent control, of the drafting or screwing is desirable.

13—About an equal number of top and bottom rolls are broken.

14—Eighty-four per cent (of a total of 87 rolls for which the records are complete) of the rolls broken during a 12-month in the sheet mills of one of the cooperating works, showed haircrack marks on the fractured faces of the rolls.

(To be continued)
30 CAR LOADS OF MILL EQUIPMENT FOR A SINGLE INSTALLATION FROM LEWIS FOUNDRY & MACHINE COMPANY

WE OFFER EXPERIENCED AND SPECIALIZED SERVICE

ROLLING MILLS
Mill Drives up to and including 6,000 HP.
Shape Straightener Machines, up to and including 24' 1 Beam.
Motor Operated Screw-Down for Mill.
High Speed Gear Sets for Continuous Rod Mills.
Continuous Bar and Billet Mills.
Roll Lathes up to and including 60''
Cold Mills for Sheet and Strip.
Rail Breakers.
Rail Re-rolling Mills
Universal Mill Spindles
Hot Saws Bar Mills
Foil Mills Pinch Rolls
Rod Reels Bar Twisters
Billet Mills Merchant Mills
Strip Reels Sheet Mill Drags
Mill Tables Steam Doublers
Sheet Mills Rail Slitting Mills
Sheet Coilers Hot Saw Tables

CHILLED IRON & IRON ALLOY ROLLS
For Hot Sheets, Tin plate and Strip
For Cold Sheets, Tin Plate and Strip
For Iron, Steel, Brass, Copper, Aluminum, Zinc and Nickel
For Merchant Bars and Rods

SHEARS
Vertical... Alligator... Cropping Plate... Squaring
Automatic Dumping Table for Bar Shears

SPECIAL MACHINERY
Ingot Turning Machine for Blooming Mill
Vertical Edging Stands
Motor Driven Furnace Billet: Pushers
Gear Cutting
Machine Work
Automobile Spring Testing Machines
Iron Castings
Steel Castings

LEWIS FOUNDRY & MACHINE COMPANY
P. O. BOX 1591
PITTSBURGH, PA.
THE STEEL PLANT BRICK MASON

New A. P. Green Unit to Make 4,000,000 Brick per Month

The A. P. Green Fire Brick Company, Mexico, Mo., has just completed the installation of its stiff mud department. This improvement now equips the new tunnel kiln plant completely, to make dry press, stiff mud and hand made shapes of all kinds. There are four tunnel kilns in the plant which give the company an approximate monthly production of 4,000,000 brick, solely in this new plant. The stiff mud machinery includes a large twin tub pug mill and huge auger machine equipped with variable speed transmission. There are four represses each equipped with variable speed transmission. All units are operated by individual motors.

Missouri Fire Brick Company Reported Sold

The Missouri Fire Brick Company, Farber, Mo., is reported to have been acquired recently by J. W. Ferguson, St. Louis, Mo.

Porcelain & Refractories Company Incorporates

Porcelain & Refractories Company, Wellsville, Ohio, has been incorporated recently with capital of 1,000 shares of stock, no par value, to manufacture and deal in porcelain specialties, refractories, etc. The company is headed by Bruce J. York, James A. Winter, and G. L. Brokaw, 108 East Sixth Street, East Liverpool.

Meeting of American Refractories Institute

The fall meeting of the Institute will be held on October 8 and 9 at the Hotel Cleveland, Cleveland, Ohio. The following program is scheduled for October 9:

Morning Session, 9:30 O'Clock


2—"Improving Dry Press Brick by the Removal of Air." Dr. George A. Bole, research professor.

New Engineering Experiment Station, Ohio State University, Columbus, Ohio.

3—"The Effect of Various Factors on Pressure Transmissions in Dry Pressing." Prof. C. M. Dodd, secretary, Committee on Dry Press Process, Rolla School of Mines, Rolla, Mo.

Afternoon Session, 1:30 O'Clock

4—"Notes on Firing of Refractories." S. M. Kier, vice president, General Refractories Company.

5—"Permeability of Refractories to Gas at High Temperatures." Stuart M. Phelps, director, Refractories Fellowship, Mellon Institute of Industrial Research.

6—Open session and discussion on Firing of Refractories, Causes of Kiln Marking and Secondary Expansion.

"Safeguarding Quality"

In a recent issue of the Executives Service Bulletin published by the Metropolitan Life Insurance Company, J. E. Lewis, president of the Harbison-Walker Refractories Company writes as follows concerning the endeavor of the company to safeguard the quality of its products:

"As the world's largest producer of refractories, Harbison-Walker Refractories Company has as its objective the maintenance of constantly improving standard of quality. To this end the company has initiated many advances in the art and consistently is availing itself of improvements in production methods.

"The company's long established policy of modernization has kept its plants equipped with efficient methods of manufacture. Its products are being used successfully in all types of service from the huge modern blast furnace installation producing in excess of 1,000 tons of metal every 24 hours and requiring millions of brick, to the smallest industrial furnace constructed with but a few hundred brick.

"Wherever possible machinery has supplanted hand operations, and continuous methods of production have been substituted for intermittent methods. An increasingly large proportion of the brick produced is being made in powerful mechanical presses. The most
"Improved" Lavino Chrome Brick

in the
Basic Open Hearth

It is a well known fact throughout the Steel Industry that the use of Lavino Chrome Brick has resulted in greater economies in the construction and maintenance of basic open hearth furnaces than any other refractory.

The use of the IMPROVED Lavino Chrome Brick will still further increase these economies.

Section through air uptake showing economical applications of IMPROVED Lavino Chrome Brick in oil fired open hearth.

A—Face all surfaces of air up-takes with nine inch header course of IMPROVED Lavino Chrome Brick. Up-takes protected in this manner last the full run of furnace.

B—IMPROVED Lavino Chrome Brick bulkheads eliminate repairs during entire furnace campaign.

C—Increased service life is secured by constructing burner dog-house with IMPROVED Lavino Chrome Brick and protecting top with prepared Lavino Chrome Ore.

D—IMPROVED Lavino Chrome Brick on port side of bridge wall protected with prepared Lavino Chrome Ore resists abrasive action of gases.

E—Slope of bridge wall is fully protected by several courses of IMPROVED Lavino Chrome Brick capped with prepared Lavino Chrome Ore.

F—End slope of IMPROVED Lavino Chrome Brick eliminates danger of wild heats cutting through.

G—IMPROVED Lavino Chrome Brick monkey walls resist molten silica wash from roof and maintain the original contour of the throat of the furnace.

The saving in first cost between Chrome and Magnesite Brick is $65.00 to $70.00 per thousand, in favor of Chrome Brick. A Better product for less money.

E.J. LAVINO AND COMPANY
REFRACTORIES DIVISION
CHROME, MAGNESITE AND SILICA REFRACTORIES
BULLITT BUILDING   PHILADELPHIA

"Pioneers in Chrome Refractories"
advantageous firing practice is secured by the use of both continuous tunnel kilns and periodic kilns.

"The company now has seven car-type continuous tunnel kilns in operation. Six of these are used for firing fireclay refractories and are located, two each, at Clearfield, Pa.; Templeton, Pa., and Vandalia, Mo. They are each approximately 450 ft. long. Coal, gas and oil are used as fuel. The seventh, approximately 500 ft. long, is located at East Chicago, Ind., and is the only tunnel kiln in America used for firing silica refractories. The fuel used is producer gas.

"For many years the Harbison-Walker Refractories Company has maintained an active Research Department. Many of the products developed in the Research Laboratory have found extensive application. We believe that only through scientific research, complete laboratory control and an organization familiar through years of actual experience in a wide variety of applications can the high quality of our products be realized and maintained."

Furnace Walls*

By George P. Reintjes

President of the George P. Reintjes Company

One of the earliest arts known is that of building a wall of brick or tile. This art was apparently developed in all countries. From the earliest times, the engineers or masons developed a brick size of twice the length to the width, the object apparently being to break the joints and bond the brick together in courses.

The earliest object of the building of a brick wall was apparently to build a house or habitation. Later, walls were built for self-preservation. Among the most remarkable of these structures in history is the great Chinese Wall.

At the present time, the greatest need for better methods of laying brick is in the building of furnaces in which to generate heat and to retain that heat until it has been utilized. Yet, strange as it may seem, the art of laying brick in furnaces, so far as the general public is concerned, has been practically a dead art.

It is no great credit to many engineers of the present day that they design furnace walls that are subjected to expansion and contraction from heat, by following the same methods of construction as were used by the Chinese in building the brick sections of their great wall that kept out the Khurds.

Some of these engineers use their entire energies in designing the furnace volumes and other engineering problems in connection with the selection of the boiler and the appendages thereto, and for

*This is the third of a series of articles by Mr. Reintjes on the subject of furnaces and refractories. The first appeared in the June, 1931, issue.

get the furnace wall structure. This reminds us of the story of a noted combustion engineer, Joseph Hays, in writing of the Arkansas farmer who very industriously pegged down the wire fence and closed all the little holes to prevent the little pigs from getting out, but forgot that the gate was off its hinges.

Do you realize that you can search the public libraries and find comparatively nothing written that will show any improvements in the art of building a wall for a furnace that is different from the walls built by the earliest of Romans? How are we to account for this?

Steel mills, oil refineries and other industrial establishments spend enormous amounts annually for the purpose of research into their various products to reduce their manufacturing cost and to increase production. Until recently it has been the custom when they had any furnace work to be done, to call union headquarters to send out as many bricklayers as were required, or the maintenance men in the plant had friends or relatives who were added to the force when the expansion program occurred.

A marked exception to this rule is where the labor cost remains constant, with apparently the same amount of repair work to be done every day throughout the year. Yet, when anything serious happens you find that the same number of masons can still take care of the major repairs. Does your plant support this latter condition?

In most of these plants, but especially in oil refineries, a contractor can contract the entire repair work and make a profit, at 75 per cent of day work costs. This is attested to by several plants where we have been doing the maintenance work, at a saving to the owners under their previous day work costs.

In the last few years contractors specializing in furnace brick work have entered the field and are gradually obtaining recognition in the various industries by their ability to build better furnaces at lower costs than those built by "day work." In spite of their competing with day work costs, they are continually studying and experimenting at their own expense methods of improving the furnace wall structure.

Many owners are still skeptical as to how this can be accomplished when the contractors are paying the same or a higher wage to their masons than is paid by the owners. The resourcefulness and ingenuity of the contractor is taxed to accomplish this. The old saying that "Necessity is the mother of invention" is doubly true. Brickmasons have been considered by many as a necessary evil, practically beyond the control of ordinary rules and regulations.

We should like to give you a summary of some of the general problems with which you, as well as the contractor, are confronted.

(To be continued)
October, 1931

Blast Furnace and Steel Plant

BESSEMER TUYERES and FIRST QUALITY FIRE BRICK

Manufacturers of "Climax" Brand Bessemer Tuyeres, Bottom Tile and Cupola Linings. Hand made "Steel" and "Atlas" Brands. "Steam Press Steel" and "Dry Press Atlas" 9" and 9" series shapes. Also difficult tile specifications. Our "Steel" Brand is used extensively in glass, malleable, and copper furnaces. May we supply your next requirements?

Climax Fire Brick Co.
Climax, Penna.

Hiram Swank's Sons, Inc.
Established 1856
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Fire Clay Refractories—Checker Blocks
Center and Bottom Plate Runner Brick, Sleeves, Nozzles, Ground Fire Clay, High Grade Fire Brick, Shapes, Ladle Brick, Radial Chimney Block

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Machine Molded gears for any purpose—
to your specifications, Bevel, Spur, Miter, Worm, Spiral, Internal, etc. Get in touch with us today.

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Rolling Mill Machinery,
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Youngstown, Ohio

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Using Bituminous and Anthracite Coals
Raw and Scrubbed Gas for Displacing Oil, City Gas,
Coal and Coke in Furnaces of All Descriptions
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NEW CONTROLLED
LUMINOUS FLAME BURNER
a luminous flame burner for natural or coke-oven gas, producing the soft mellow flame of a coal fire.
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Combines the full pipe area delivery of a gate valve with the quick action of a stopcock, costs less than either.
Furnished with either threaded or flanged connections for use on standard wrought iron piping, spiral riveted or ordinary sheet steel piping.
Enables a substantial saving in installation costs.
Prevents escape of air, waste of power, loss of money.
Is strong, light and air-tight.
Gives more perfect control than any other blast gate.
The blade stays put.
Write for copy of Bulletin 303-V giving more details regarding this furnace.

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MADE FROM
CAST STEEL, FORGED STEEL, CAST IRON, BRASS, RAWHIDE, BAKELITE, MICARTA, FIBROC AND FORMICA
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we build a complete line for
WIRE of all kinds, COLD DRAWN or HOT ROLLED STEEL, ROUNDS, SQUARES, HEXAGONS, RECTANGLES, ETC., also STRIP and SHEET METALS

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"UNIVERSAL" CHECKER FOR HOT BLAST STOVES (Patented)

Pennsylvania Engineering Works
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Steel Plate Construction
For all Industries
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AMERICAN ROLLER BEARINGS
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Cut production costs, obtain greater load capacity with an absence of those costly bearing renewal delays. American Roller Bearings can be installed in your equipment without any radical changes from your present design.
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THE MANUFACTURE OF STEEL SHEETS
By Edward S. Lawrence
244 pages, 116 illustrations, 9 tables
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The only book published on this subject and written in non-technical language.
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HAMMER MILLS
Renewable Six-Edged Cutter Tips with Permanent Arms
Save Power, Crush Finer, Increase Capacity
Insure Greater Efficiency at Reduced Cost
Enduring as the Pyramids
JOSEPH L. HILLER
MATTAPoisett, Mass.

POSITION WANTED
GRADUATE CHEMIST with 5 years’ university training, 8 years’ experience, desires position as analytical, research or plant chemist. Four years’ experience in iron and steel, turn foreman in laboratory. Address Box X-361, care of Blast Furnace and Steel Plant.

POSITION WANTED—Electrical, mechanical and power engineer with experience in design, specifications and construction of machinery, power plants, in steel works and rolling mills, desires position. Address Box X-357, care of Blast Furnace and Steel Plant.

POSITION WANTED by Representative Engineer with 25 years experience in steel plants, machinery and coke plants, wishes to connect with representative concern. I recently returned from Europe studying European conditions and I am personally acquainted with the highest executives of the steel, iron and coke industry in Germany. Write to Box X-356, care of Blast Furnace and Steel Plant.

POSITION WANTED—Young man, chemical graduate desires position with a future. Not afraid of work, willing to do anything around plant or laboratory. Satisfied with a small salary to start. Address Box X-359, care of Blast Furnace and Steel Plant.

FOR SALE
FOR SALE—Concern of long and favorable standing in Pipe Bending and General Welding Business (Pittsburgh) for sale at exceptional price to settle estate. Very substantial list of customers. For particulars write Box X-360, care of Blast Furnace and Steel Plant.

MISCELLANEOUS
TRACING SERVICE—All kinds of engineering work traced quickly, neatly and reasonably. For particulars write Box X-351, care of Blast Furnace and Steel Plant.
Blast Furnace & Steel Plant

BUYERS GUIDE

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Cement—Cupola Linings
Harbison-Walker Ref. Co., The
Mackintosh-Hemphill Co.
General Refractories Co.
Lavino & Co., E. J.
Mesta Machine Co.

Concrete—High Temperature
Mesta Machine Co.

Conveyors—Cable
Borroughs  & Co., Arthur G.
Mesta Machine Co.

Couplings—Flexible
Harsco Engineering Co., The
Mesta Machine Co.

Cranes—Hot Metal
Allis-Chalmers Mfg. Co.

R.C. Engineers

Dredges—Roots
Allis-Chalmers Mfg. Co.

Elevators—Automatic
Johns-Manville Corp.

Electric Generators
General Electric Co.

Electric Motors
General Electric Co.

Elongated Taper Studs
Allis-Chalmers Mfg. Co.

Endura-Standard Eng. Co., The
Lewin Foundry & Mach. Co.

Engineering Co., The
Mesta Machine Co.

Engineers—Morgan
Morgan Engineering Co., The

Erectors—Crane
Mesta Machine Co.

Furnace—High Temperature
Hagan Co., George J.

Furnace—Water, High Temperature
Allis-Chalmers Mfg. Co.

General Electric Co.

General Electric Co.

General Refractories Co.

General Refractories Co.

General Refractories Co.

General Refractories Co.

Glass—Veneer
Allis-Chalmers Mfg. Co.

Grinding Machines
Allis-Chalmers Mfg. Co.

Grinders—One Way
Link-Belt Co.

Grounding Rods
Harbison-Walker Ref. Co.


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Mesta Machine Co.


Mesta Machine Co.


guage—Magnetic
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Koppers Construction Co., The


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guage—Universal
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guage—Burdening
Mesta Machine Co.


guage—Burdening
Mesta Machine Co.


guage—Burdening
Mesta Machine Co.


guage—Burdening
Mesta Machine Co.


guage—Surface
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Hose—Rubber, Oxy-Acetylene.

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Liquified Lard.

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Machines—For Oil, Kerosene, Gasoline, Nitric Acid.

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Steel—Heat Resisting Alloy.
Michigan Steel Castings Co.

Steel—Building and Structural.
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Steel—Heat Resisting Alloy.
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Steel—Building and Structural.
Michigan Steel Castings Co.

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Steel—Building and Structural.
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Misco alloys comprise a group of chromium-iron and chromium-nickel-iron alloys, each intended for use under specific conditions of service.

The various properties of these alloys have been carefully studied, under both laboratory and operating conditions, during many years in which the makers of MISCO have been engaged in the manufacture of heat and corrosion resistant alloys.

### Nickel-Chromium Alloys
- 65 NI-15 CR
- 35 NI-15 CR
- 25 NI-10 CR

### Chromium-Nickel Alloys
- 30 CR-10 NI
- 24 CR-12 NI
- 18 CR-8 NI

### Chromium-Iron Alloys
- 28 CR-18 CR
- 18 CR-14 CR

To users of these alloys, the makers of MISCO offer unequaled production facilities upon which they can depend for prompt shipment of castings, rolled products or fabricated structures, which can be relied upon to give satisfactory and long service life.

**Michigan Steel Casting Company**

1988 Guion Street
Detroit, Michigan

Misco alloys are made in three electric furnaces; one capable of melting as little as 250 pounds; another up to 10,000 pounds.

Misco alloys comprise a group of chromium-iron and chromium-nickel-iron alloys, each intended for use under specific conditions of service.
Comparative Daily Cost of Switching C. B. & Q. Industry Tracks at Crete, Neb

<table>
<thead>
<tr>
<th></th>
<th>Steam Switcher</th>
<th>Gas Electric</th>
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<tr>
<td>Engineman</td>
<td>$7.16</td>
<td>$7.16</td>
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<tr>
<td>Fireman</td>
<td>$5.63</td>
<td>$5.63</td>
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<tr>
<td>Coal, 5.6 tons at $4.36 (including $11.82 freight)</td>
<td>21.86</td>
<td>Gasoline 4.42</td>
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<tr>
<td>Wood</td>
<td>44</td>
<td></td>
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<tr>
<td>Water, 2 tanks</td>
<td>2.00</td>
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<tr>
<td>Oil and waste</td>
<td>.33</td>
<td>.40</td>
</tr>
<tr>
<td>Other supplies</td>
<td>.53</td>
<td>.53</td>
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<tr>
<td>Enginehouse service</td>
<td>7.34</td>
<td>4.07</td>
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<tr>
<td>Running repairs</td>
<td>8.08</td>
<td>4.48</td>
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<tr>
<td>Total</td>
<td>$55.37</td>
<td>$21.06</td>
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18 Ton Fireless . . . Lowest cost unit in existence for light or intermittent service.

32½ Ton Fireless for heavy plant switching. Cheap; fireproof; available; clean; one-man.

67 Ton Fireless
"Paid for itself in 2 years".

Gasoline Electric
Fireless ...........
Oil Electric .......
Standard Steam .
Gasoline .........

ALL in SUCCESSFUL operation
ALL giving results

H. K. PORTER COMPANY
PITTSBURGH, PA.
Established 1865

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44 Whitehall St.

CHICAGO OFFICE
Wells St. & Wacker Drive

Builders of Steam, Fireless Steam, Gasoline-Electric, Oil-Electric, Gasoline and Compressed Air Locomotives
TIGHT… UNDER ALL CONDITIONS

After long research and a great deal of severe service testing we announced this new feature in gate valves. Users say it is the greatest valve advance in a generation.

**Lubrotite** Gate Valves solve your troubles; in places where service conditions promptly make new valves leak—it keeps them tight.

**Lubrotite** Gate Valves, even when mutilated in service, remain tight. The thin film of lubricant-seal applied to the seating surfaces closes scratches, scores and dents against leakage. And this sealing action prevents such damages from growing.

If corrosion is one of your troubles, this film of lubricant-seal is a protection to the seats. It also overcomes sticking due to deposits or long disuse. A turn on the lubricant guns frees the wedge, virtually prying it loose.

Special lubricant-seals have been developed for particular services. This is put up in standard sized cartridges in convenient pocket-fitting boxes. Loading is very easy.

The **LUBROTITE** feature is available in all Reading-Pratt & Cady Iron and Electric Cast Steel Gate Valves.

**READING-PRATT & CADY COMPANY, Inc.**
Bridgeport, Connecticut
Boston Charlotte Chicago Cleveland
Detroit Hartford Houston New York
Philadelphia Pittsburgh Rochester
St. Louis San Francisco Tulsa

**MAIL TODAY FOR ILLUSTRATED DESCRIPTIVE BOOKLET**

**Lubrotite**
IRON AND STEEL GATE VALVES
ROLLING MILL MACHINERY

SPECIAL CHILLED ROLLS  PLAIN CHILLED ROLLS
SAND ROLLS  COLD ROLLS

EXTRA HARD ROLLS FOR BRASS, COPPER, ALUMINUM

The National Roll & Foundry Company
Office and Works: AVONMORE, PA., U.S.A.
Surface Combustion's furnace service to the steel industry is complete from roughing to finishing. One-way fired soaking pits... roughing furnaces... pack and pair heaters... box annealers... walking beam normalizing furnaces... tube normalizers... all designed and built by Surface Combustion under the direction of a great specialized engineering staff with years of experience in steel mill heating practice. Successful installations of all types in leading steel mills of this country are ample evidence of Surface Combustion's leadership in the building of steel mill heating equipment.

OPERATED BY HENRY L. DOMERTY & COMPANY

Surface Combustion

SURFACE COMBUSTION CORPORATION
TOLEDO, OHIO.

SALES AND ENGINEERING SERVICE
IN PRINCIPAL CITIES
IF YOU ARE PAYING FOR NEW EQUIPMENT

Users of obsolete machinery are spending many times-in high production costs-the price of new equipment.

Have you ever thought of this? Almost 50% of the steel mill machinery and equipment now in use, in the steel plants of this country, is over ten years old; and, speaking in general, machinery that is ten years old is out of date.

Machinery that has been operating for just a very few years may also be outmoded, for the reason that any machine is out of date just as soon as another machine is developed that will do the same work in a better or cheaper way.

In times like these it becomes necessary to keep production costs at the very lowest level. Companies who can do this can show a profit, even in the dullest years, simply because they are able to keep their costs below market prices. Others, who are not so fortunate are forced to close their plants until the dull period has passed. It is to these companies - the ones that are closed down or who may be operating with their backs to the wall - that this message is written.

If you, in your plant, are attempting to operate with machinery and equipment that is out of date, expensive to operate, thereby creating a high production cost, is it not true that you - and you alone - are paying for your competitors' newer and better equipment?

To postpone, until times get better, the replacement of out of date machinery, when it is a recognized fact that new machinery would pay for itself, in lowered production costs, is the lowest manifestation of false economy.

To wait for better times to replace old equipment is a dangerous practice --- what if times should not get better? Who then will be in the better position to make the best of it and gather in what profits can be made on what business there is? Will it be the manufacturer who sticks to his obsolete equipment? .... no!! .... In such a condition of circumstances it would be the modern equipped plant that would reap the profits.

Remember this .... Whether you are operating with old style equipment or are shut down and waiting for better times....the newer, better, low production cost machinery, in the plant of your competitor - is being paid for by you.

OUR BUSINESS IS DESIGNING AND BUILDING MACHINES FOR ROLLING AND FINISHING STEEL
November, 1931

Blast Furnace & Steel Plant

The photographs below show an AETNA-STANDARD Billet Mill, in the plant of one of the largest steel makers in the world.

These views show one instance of how AETNA-STANDARD is building for the good of the steel industry.

If there ever was a time when you needed the advice and assistance of competent engineering minds -- that time is now. We believe that our staff of steel mill analysts can be of help to you in the lowering of your production costs, in the increasing of your tonnage and in the bettering of the quality of your products and we offer you, without obligation, the opportunity to go over your production problems with them.

These men, thoroughly grounded in the traditions of AETNA-STANDARD, will welcome the chance of making an analysis of your equipment from start to finish and will give you an unbiased report on the condition found there -- a report that will point the way to profit making operation.

The AETNA-STANDARD

ENGINEERING CO., YOUNGSTOWN, OHIO
Double Layer Insulation saves fuel

Armstrong’s and Nonpareil Insulating Brick stop heat waste in Cowan Kilns

Firebrick inside... steel shell without. And in between, a double layer of Insulating Brick—Armstrong’s and Nonpareil. That’s how Cowan Pottery Company insures against heat loss in the new down-draft kilns of its Cleveland plant.

It’s good insurance, too, as others besides Cowan have learned. For both of these Armstrong Brick are built to guard high temperatures. In kilns and lehrs of every type and size, they are saving thousands of dollars yearly by preventing heat loss.

Many instances are on record where the installation of insulating brick has resulted in fuel savings of from 10% to 40%.

There’s added economy in the fact that both Armstrong’s and Nonpareil Insulating Brick are accurately machine-sized. That means faster laying, with a tighter, more efficient wall. These brick often are laid up dry, saving labor and materials. Their exceptionally high salvage value represents an additional saving.

Armstrong’s Insulating Brick are burned at more than 2500° F. They serve efficiently under temperatures as high as 2500° F. behind the refractory, without warping or fusing. Nonpareil are safely used up to 1600° F. Both are light and have ample strength for any type of construction. They are furnished in all standard firebrick sizes, and in special shapes to order.

Armstrong engineers will gladly help you just as they did Cowan plan savings in your own plant with these brick. Samples of each sent on request.

Armstrong Cork & Insulation Company, 941 Concord Street, Lancaster, Pennsylvania; Canadian offices in Montreal, Toronto, and Winnipeg.

Armstrong’s and Nonpareil Insulating Brick for Furnaces, Boilers, Kilns, and Lehrs
The Brassert Automatic Filter prevents the clogging of sewers, stops pollution of streams and cleans itself.

The Brassert Automatic Filter has numerous applications in blast furnaces and steel plants. It filters a large volume of liquid carrying a high percentage of foreign matter, and requires no attention because it continuously cleans itself. A few of its uses are:

**Main Water Service**
The filter assures clean water for water-cooled elements.

**Granulating Slag**
It protects sewers from clogging and prevents the accumulation of solids where sewers empty into a lake or river.

**De-Scaling System**
The Brassert Filter permits the use of small orifices on high pressure systems for removing scale from rolled products.

A complete range of sizes is available for various purposes. Let us know of any problem you may have that is caused by excessive solids in your liquids and we will gladly make a practical recommendation for its solution.

H. A. Brassert & Co.
Engineers and Contractors
CHICAGO—310 S. Michigan Ave.
NEW YORK—Lincoln Building
LONDON—Brook House, Walbrook, E.C.4

The drawing at the right shows how the cleaning water jets through the screening area as the screen cylinder revolves.
MANTLE RECUPERATORS
PROFITABLY APPLIED TO ALMOST EVERY TYPE OF INDUSTRIAL FURNACE

Request the new MANTLE RECUPERATOR CATALOG and data book. You will be interested in the valuable, exclusive information it contains.

Properly applied recuperation increases industrial furnace efficiency from TWENTY TO FIFTY PER CENT! In these days when production economy is so essential hundreds of Mantle Recuperators are demonstrating decided savings in fuel costs. For years Mantle engineers have specialized in the application of metallic recuperation to a wide variety of industrial furnaces. It is certain that they can increase the efficiency of your furnace after a proper survey of your equipment. They can tell you just how much Mantle Recuperators will save! Write today . . . there will be no obligation, of course.

Operated by Henry L. Doherty & Company
Surface Combustion
Surface Combustion Corporation
Toledo, Ohio
Sales and Engineering Service in Principal Cities
THE original American Multi-Panel Air Filter in steel mill service was installed in September, 1928, and has operated efficiently for three years—24 hours a day, 156 hours a week, 50 weeks a year—which is the equivalent of nine years of normal service.

Dust concentration in the average steel mill is approximately 2.4 grains per thousand cubic foot of air, as against approximately 1 grain in ordinary ventilation service. Consequently, you will see that the three years this American Multi-Panel Air Filter has been in operation are equal to at least twenty-two years where dust conditions are normal and the filter is only working 8 hours per day.

If dust is interfering with the operation of the machinery in your plant, let our research staff show you how it can be eliminated. Learn what dust is costing YOU.

AMERICAN AIR FILTER CO., Inc.
109 Central Avenue Louisville, Kentucky
In Canada, MIDWEST CANADA LTD., Montreal
Cut production costs with Alumino Hi-Temp Insulation

Carey Alumino Hi-Temp, the new alumina base heat insulation, is rapidly replacing less efficient materials on gas and electric furnaces, kilns, regenerators, lehrs, etc., having internal temperatures of 2500°F to 3000°F. Scientific tests prove that 5" of Alumino Hi-Temp equals in efficiency a 9" wall built of insulating brick. The consequent reduction in first cost is important, and frequently the space saved permits increased apparatus efficiency.

One block of Alumino Hi-Temp 9" x 36" replaces more than 14 insulating brick 2½" x 9", and installation labor is accordingly reduced. The insulation joint area is cut about 75%, saving heat which would otherwise escape through joints.

Write for samples and data on Alumino Hi-Temp, or better still, outline the conditions in your plant, and we will promptly supply full information on the savings which can be made.

THE PHILIP CAREY COMPANY  Lockland, Cincinnati, Ohio
Branches in Principal Cities
No. 2 Cooling Bed on the 42nd completed Merchant Mill designed and built by Morgan Construction Company and the 159th Mill completely Morgan designed and built. These Cooling Beds are built with machined notches to handle all merchant bar sections, angles and flats, as well as spring bars in packs for annealing, and maintain straightness while cooling.

MORGAN CONSTRUCTION COMPANY
Worcester, Mass., U. S. A.

EUROPEAN REPRESENTATIVES:
Davy Bros., Sheffield, England
"The outstanding monthly business-paper to the steel plants—editorial contents devoted exclusively to discussion of the engineering and production of iron and steel."

BLAST FURNACE AND STEEL PLANT has a greater circulation in the steel plants than any other two steel publications combined.
72% of its subscribers have requested that their copy be sent each month to their home address—a remarkable demonstration of reader interest.

(A) BLAST FURNACE AND STEEL PLANT is managed and edited by former steel plant operating officials. The combined service in steel plants of the members of the editorial staff amounts to twenty-seven years.

(B) 76.25% of the circulation of BLAST FURNACE AND STEEL PLANT goes to general superintendents, managers, chief and department engineers, chemists and metallurgists, foremen, rolling mill superintendents, roll designers, roll turners, draftsmen and safety inspectors.

(C) 15.44% of the circulation goes to companies and executives. This makes a total usable advertising circulation to you of 91.69%—a potent field indeed for your sales message.

(D) During 1931 most business papers have suffered great losses in their circulation in steel plants. During this period BLAST FURNACE AND STEEL PLANT circulation loss is 3.4%. This shows the reliance the steel industry has in BLAST FURNACE AND STEEL PLANT.

CATIONS • INC. •
PITTSBURGH, PA.
You'll never count the take if you're afraid to take the count

Trying to run your business without knowing what the rest of the industry is doing is pretty much like shadow boxing. It is good exercise, but it seldom shows results at the boxoffice.

The way to find out whether you are getting anywhere is to swap punches with the other fellow.

You can do this to your heart's content at the 1931 Convention of the International Acetylene Association in Chicago on November 11, 12 and 13. The leaders in every branch of welding will be there to batter you with new ideas. If you disagree with them, there will be plenty of chances to counter with better ones. Open discussion will be one of the features of this year's meeting.

Maybe you will find that they can teach you a thing or two. Maybe you will be able to give them a few pointers. But whatever the outcome, the experience will be a lot more profitable than solo-sparring with the blue shadows of depression in your own office.

Pack your bag and be there for the first round on November 11. Everyone is welcome.

Here are some of the free-for-all discussions scheduled for the 1931 Convention:

WELDING AND INDUSTRY IN 1932
TRAINING WELDERS AND TESTING WELDS
WELDING IN THE TRANSPORTATION INDUSTRIES
WELDED PIPING AND PIPE LINES
WELDING IN THE CHEMICAL INDUSTRY
EDUCATION IN WELDING

32nd Annual Convention
Congress Hotel
Chicago
Nov. 11 • 12 • 13 • 1931

INTERNATIONAL ACETYLENE ASSOCIATION
ESTABLISHED 1898
30 EAST 42nd STREET, NEW YORK
In the Model Plant of Columbia Malleable...
A MODEL plant is the malleable iron foundry of the Columbia Malleable Castings Corporation, Columbia, Pa. Its buildings are laid out in three parallel wings, providing straight line production from raw materials to finished product.

Melting is done in two 25 ton reverberatory type air furnaces, equipped for both pulverized fuel and oil firing. Castings are annealed in a continuous annealing kiln, 182 feet long, holding 22 cars at a time.

Modern equipment and efficiency feature the entire plant layout—even the interior walls of the shops are surfaced with aluminum paint for maximum reflection of light.

For its malleable furnaces and continuous annealing kiln and for all other refractories requirements, Columbia Malleable selected Harbison-Walker Refractories.

If you use refractories in malleable furnaces, or in any types of ferrous or non-ferrous melting or annealing furnaces, we have interesting data on the performance of Harbison-Walker products.
THE efficient, silent, self-contained DE LAVAL WORM REDUCTION GEAR is, like the electric motor which it serves, the result of specialized, large scale production on a precision basis. Its scientific design and high grade construction adapt it for continuous, heavy service. It requires no attention further than to supply oil at long intervals.
WHAT PRICE IMPROVEMENT?

Industry must take advantage of every technological advance to improve the quality of its products and lower the cost of production. In no other way can markets be maintained and developed.

But each proposed improvement must be carefully weighed. What will it cost? Can it be kept busy? Will its savings return the money invested in the facilities it replaces and leave anything over?

It is not enough to know that a new machine or method works. Either increased sales or decreased manufacturing costs, or both, are necessary to justify additional capital costs.

Proper valuation of all these elements in industry requires technical knowledge and many years of actual experience.

For a quarter of a century Arthur G. McKee & Co. has made financial and technical surveys, investigations and reports for large clients in the iron and steel industry, as well as undertaking engineering work, designing, and actual construction of important projects in many parts of the world.

Whether your problem involves decision on the practicability of projected improvements or design and construction of new units, this company can help you.

ARTHUR G. McKEE & CO.

Engineers and Contractors  •  2422 Euclid Avenue, Cleveland, Ohio
120 Broadway, New York  •  Bush, House Aldwych, W. C. 2, London

Associated with
PETROLEUM ENGINEERING, INC.
Tulsa, Oklahoma  •  Dallas, Texas

THE WHESSOE FOUNDRY & ENGINEERING CO., LTD.
Darlington, England  •  25 Victoria Street, S. W. 1, London
Blast Furnace and Steel Plant

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Volume XIX NOVEMBER, 1931 Number 11

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Published the first of each month by Steel Publications Incorporated
Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.

DON N. WATKINS, President D. S. WATKINS, Vice President M. M. ZEDER, Secy.-Treas.

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STEEL PUBLICATIONS INC.
29 West Thirty-fourth Street
New York, N. Y.

WESTERN MANAGER
GLEN W. NEELY
526 North Grove Avenue
Oak Park, Ill.

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Seven million tons of By-product coke and gas plant capacity operated by Koppers, subjects our production equipment to continuous analysis. First hand information on changing conditions in coal supply, coke distributing areas, special progressing, finds its way to the pool of Koppers experience where it is used for immediate or prospective design of equipment or plant layout. Normally, construction operations provide continued new design but Koppers is unique in having at all times the incentive of an operating business to keep Koppers equipment abreast of markets for coke or gas.


THE KOPPERS CONSTRUCTION COMPANY
KOPPERS BUILDING
PITTSBURGH, PA.
Research Needed

At a recent meeting of steel company officials and metallurgists, several speeches were delivered and in each the speaker called attention to the benefits to be secured from research. The opinion was general that what is needed today is not a curtailment of our research work, but an extension of it. Instances were cited to uphold this contention.

Formerly, research was considered as having application only to the scientific aspects of an industry, but that is not the viewpoint today. Research is as applicable to the sales and distribution fields as it is to any other field. The existence of conditions such as we are now experiencing is ample proof of the lack of research. Possibly the widespread distress that exists today could have been avoided had there been more attention given to an intensive investigation of the causes from which we are suffering. The best evidence of the failure to appreciate the benefits of research is furnished by the reverses of a business organization.

The very fact that a company maintains a well organized research department should be convincing evidence that that company is alert, and is not content to rest upon past accomplishments however excellent they might have been. Then too, what better assurance does a customer need, than to be informed that the company from which his purchases are made is endeavoring by continuous research to improve its products? That is not only assurance; it is insurance.
This page illustration is given over to the employment of steel castings as manufactured by the builder of heavy rolling mill equipment and their consumption in the builder's product.

It's 'BIRDSBORO' throughout...

even to its 128,900 lbs. of steel castings

Huge 50,000 lb. ingots extracted from the soaking pit and lowered, with a possible slip, into the carrier-pot of a delivery car—requires of that car a construction of utmost ruggedness to withstand the abuse of the mill.

With this in mind, Birdsboro designed and built complete for one of the country's great steel corporations, an ingot delivery car featuring such factors of safety as a fully enclosed armor of cast steel for motor and control protection, a heavy spring arrangement for the prevention of shock to operating crank-shaft; and a bed frame of well reinforced sections. The car operates on standard gauge track and on roller bearings thus facilitating travel between pit and table.

BIRDSBORO
STEEL FOUNDRY AND MACHINE COMPANY
DESIGNERS AND BUILDERS
BIRDSBORO, PENNSYLVANIA
Steelmakers are Optimistic

At the fall meeting of the American Iron and Steel Institute held in New York on October 23, both James A. Farrell and Charles M. Schwab expressed the opinion that there are “favorable indications” of a return to “reasonable prosperity” in the steel industry.

“These favorable indications,” said Mr. Farrell, “while not as pronounced as we would wish, tend to strengthen the conviction that the resources of the nation are being mobilized in an effort to shake off the despondency which has hampered enterprise, and the lack of confidence which has curtailed consumers’ demands. Suffering as we are, both from underproduction and underconsumption, it is of prime importance to strengthen the confidence of our people in the future of the country and in a return to reasonable prosperity.

“American industry has had to bear the brunt of ill-formed theorists, some of whom seek to take advantage of the situation to undermine public confidence in the capacity and soundness of our industrial system.”

Mr. Schwab’s optimism found expression when he said:

“I am going to speak straight from the shoulder. Let us recognize that we have a great depression and deal with it as such. I can speak much more cheerfully than would have been reasonable a month ago. The improving of our credit structure by virtue of the steps advocated by President Hoover and the bankers is a fundamental step in the right direction. Fear has been lessened. There will be no collapse. The sources of credit have been mobilized, and we shall pull through. I have seen us pull through too many crises to be overwhelmed by the situation of the past months.

“Our house is in order. The financial world is straightening itself out. Industry has gotten its second wind. Let us sail into the job ahead of us. Keep up the selling campaigns, keep up advertising, improve your production methods. Face the difficulties, but with courage, confidence and knowledge that we are on the upward path. Our industry will do its part.

“Let us forget predictions and panaceas. Let us manage as efficiently and economically as we know how. Remember this: Just as soon as our business and the business of the country begin to show an upward trend in profits, that will be the real beacon of prosperity. It was so a century ago; it is so today.”

Besides the hopeful remarks of Mr. Farrell and Mr. Schwab, other steelmakers, Eugene G. Grace, T. M. Girdler, L. E. Block, L. E. Geohegan and E. T. Weir, also expressed the belief that the industry will soon enter a period of greater prosperity.

Following the address of the president of the institute, L. S. O’Roark of the Bell Telephone Laboratories presented a paper on Experiments in Speech and Music. One other paper, The Bessemer Process and Its Product, by Professor R. S. McCaffery, University of Wisconsin, was delivered at the morning session. At the afternoon session three papers were presented:

The Metallic Charge in Basic Open Hearth Operations—Some Factors Affecting Operating Economies, by C. D. King, chairman open hearth committee, United States Steel Corporation, New York, N. Y.;

(Continued on page 1458)
The invention and patenting in 1855 of the Bessemer process made possible the production of the first "low cost" steel the world has ever known. It marked a turning point in our industry and in our civilization. In our country, with the western movement of our people and with industrialization making vast strides where settlement was thickest, there came the demand for new tools and structures and for the binding together of all the parts of our country by railroad construction, all of which could be satisfied with the new low cost steel. The first Bessemer steel rails produced in the United States were rolled at the Chicago Rolling Mill in 1865. The invention of the Bessemer process was probably the greatest single factor contributing to our spectacular material development in the period between the Civil War and the beginning of the new century.

The particular variety of Bessemer process developed in the United States was the acid process because we had large reserves of iron ores of sufficiently low phosphorus content—of "Bessemer grade"—which could be made into steel without the necessity for the removal of any of the phosphorus and still furnish a steel with proper physical properties, containing not more than 0.10 per cent phosphorus.

On account of the enormous demand for steel in our rapidly growing and expanding country, and with it the relative decrease in the Bessemer ore reserves, the other new steel making process, the open-hearth process, began to receive more attention. It furnished an outlet for the non-Bessemer grades of ore, but it also found an advantageous raw material in the steel scrap that was becoming available in larger quantities. The Bessemer process could not employ all this steel scrap so that the open-hearth with the scrap advantage began to increase in tonnage and in 1905 its production exceeded that of the Bessemer process. Since then open-hearth steel has proceeded at an increasing ratio of production till only a few years back when Bessemer steel began to reassert itself very decidedly. A most interesting comeback has been taking place which many users of steel seem to have overlooked; it might be possible to describe it even as a resurrection of the Bessemer process because so many persons had said it was dying that some actually believed it was dead.

There has been a change of conditions and of economic factors taking place for some years past. It...
has been gradual but continuous and it has put the Bessemer process in a decidedly different position compared with that which it occupied a few years ago. For example, in this country we now have relatively a much larger Bessemer ore reserve than we formerly possessed; in fact a reserve amply sufficient for a Bessemer operation of present scope for a considerable time in the future. Then, too, there have been scientific and technical advances in fields parallel to that of metallurgy. These have greatly increased our knowledge of metallurgical chemistry; they have given us new instruments that help us to obtain better process control, and new designs of equipment and machines have been developed which enable us to make this new knowledge available in production.

All these things were applied to the open-hearth process first and it is only lately that the Bessemer process has received the consideration which it deserves. It is being provided with adequate facilities and equipment and it is now making products with desirable properties which cannot be reproduced in any of the other steel making processes. There are no technical reasons why its use should not extend into the fields now served by competing processes. There are no technical reasons why for certain purposes it should not make at least as good if not a better quality of steel product than its competitors. The men who make Bessemer steel seem to have been afflicted for years with a sense of inferiority which certainly was not helpful or conducive to improvement in quality. Steel buyers were very reluctant even to consider Bessemer steel for the rapidly increasing uses in which steel was employed. Happily these conditions have changed for the better and the Bessemer man now knows he can make fine steel and he does make it. Buyers have discovered this, so that today Bessemer retains its place for those uses where it has always been pre- eminent and it has successfully replaced other steels in some of the newer uses.

Our Bessemer process of today, while not changed in principles is in many respects, particularly in details, quite different from what it was a few years back. All the new refinements tend towards uniformity of product and improvement in quality. To point them out and explain their influence on uniformity and quality, it is necessary to describe the Bessemer process at this present stage of its development.

**Plant Practice**

The pig iron from certain blast furnaces, which are producing Bessemer grade pig of suitable silicon, manganese, phosphorus and sulphur specification, is taken from the blast furnaces where it is cast into ladles and transported to the steel plant. Here the molten iron is poured into a "mixer" or storage reservoir which serves the purpose of equalizing the differences in composition of the casts of blast furnace metal from which the steel is made. A large modern mixer holds about 1300 tons of iron. A large mixer then tends to provide metal of uniform composition for the converters.

After a converter has poured its previous blow and has dumped out the slag, it is turned up to a position to receive the mixer metal, a weighed quantity of which is brought to it by a transfer ladle. When the charge of mixer metal is in the converter, the air blast is turned on, the vessel brought to upright position and usually a cold metal addition of steel or of pig iron is made to the blowing charge in the converter. The amount of this cold metal addition is determined by the temperature and silicon content of the mixer metal.

If the cold metal addition be steel, it adds no silicon to the metal bath; if it be pig iron it does add silicon to the bath. If a larger amount of cold metal be added, the temperature of the metal bath is lowered more than if a small cold metal addition be made. The result is that immediately at the beginning of the blow a standard uniform initial temperature and silicon content is approached.

In the usual Bessemer process, as practiced in the United States, the silicon and manganese along with some iron are oxidized in the early part of the blow, and a slag is formed composed of silicates of iron and manganese. The gases which pass off from the throat of the converter during this stage of the blow are mostly nitrogen. The bath temperature during this stage of the blow increases rapidly, the greater part of the heat being furnished by the burning of the silicon to silica, although the oxidation of the iron and the manganese furnish additional heat. There is relatively little carbon burned out during this first stage.

With the elimination of the silicon and manganese, the carbon begins to burn out very actively, producing carbon monoxide which makes a long yellow flame when it burns to carbon dioxide at the throat of the converter.

If the carbon in the bath burns to carbon monoxide, the heat produced during the carbon blow does not increase the bath temperature so rapidly as it increases during the silicon blow. Practically, the temperature at the end of the blow is dependent on the silicon content and the initial temperature of the bath as regulated by the cold metal additions, since the carbon content of irons is about constant.
the finishing temperature and thus avoid the necessity of introducing steam toward the end of the blow to lower the temperature of the bath; or of blowing with the converter tilted and some tuyeres emerged, to raise the temperature. In general, the steaming of a converter blow is poor practice because when it is done, it means the addition of an uncontrolled amount of a new chemical reagent, and also the uncontrolled lowering of the converter temperature. The effect of tilted blowing is also bad for the reasons which will be brought out later, when the use of too high blowing pressures is discussed.

It will be noted that the description of a blow as outlined above is a little different than that ordinarily given and some things are done now that did not generally known until now regarding the Bessemer blows. In Fig. 2, where constant pressure was maintained from the time when cold metal additions had been completed, it will be noted that the volume remained practically constant in the early part of the blow, but in the latter part the volume increased rapidly from 18,000 cu. ft. per min. to 30,000 cu. ft. per min., although the pressure remained the same. In this case, while maintaining constant pressure, the volume increased at the end of the blow by about 60 per cent. It will be noted too that the slope of this volume curve decreases and flattens out just before the turn down.

Fig. 3, plotted similarly with volume kept constant, shows corresponding pressure decreases.

This variation of metal bath resistance to the blast is caused by the changes in viscosity of the bath because of changes of composition and temperature and also by the increase of weight of the bath due to formation of silica and other oxides in the early part of the blow and to a decrease in bath weight due to the elimination of carbon toward the end of the blow.

In Fig. 2 the point at which the increase of air volume takes place when operating at constant pressure is the place where "splitting" begins in the usual spitting blow. While the heat illustrated in Fig. 3 was blown and the blast volume was maintained constant, a second converter was charged with metal from the same mixer about five minutes after the first converter received its charge. This latter heat was given the same cold metal addition but was blown so as to maintain fairly constant pressure. The blowing time of the two heats was exactly the same, but the heat blown while maintaining the blast volume constant did not split at all, while the second blow with practically identical metal charge, same initial temperature, same weight of metal, and same cold metal addition as speed, as the necessities of the blow may require. The operator has a pressure gauge, a volume meter and a tachometer on the board in front of him along with the start, stop and speed regulation buttons. There has never before been possible in this country the exactness of control of the converter now realized in this plant.

To illustrate the control that it is possible to obtain, Fig. 1* shows the recorder chart made on two soft steel blows, the one blow maintaining constant pressure, after the period of cold metal additions to the end of the blow, and the other blow similarly maintaining constant volume for the same time. The data from Fig. 1 are redrawn in Fig. 2 for the blow at constant pressure and in Fig. 3 for the blow at constant volume.

In addition to the nicety of control of the operation now possible, these curves bring out some facts which were not generally known. The data in this plant show the exactness of control of the converter.

Equipment

There has been a recent installation in one of our steel plants of electrically driven blowing equipment. Each converter is provided with an individual motor-driven centrifugal blowing unit on an individual air line to the converter. The equipment is arranged so that any blower may be connected with any converter. The control of these blowers is entirely from the blowing pulpit. The operators start or stop the machines, or increase or decrease their

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*The mechanism for the more rapid drive of the chart makes the marked interval of one hour on the chart actually represent about 25 minutes, rotated antclockwise. This must be allowed for in examining the chart.
The Metallic Charge
in Basic Open-Hearth Operations

By CLARENCE D. KING
Chairman
Open-Hearth Committee
United States Steel Corporation

The intensive study in recent years of open-hearth operations has led to notable improvements in production rates, fuel consumption, furnace life, and in those costs for which the open-hearth operator is normally held responsible. Since he is furnished raw materials in quality and prices over which he has no control, generally, in his opinion the ultimate cost of the net metallic mixture is fixed and his criterion of the performance of the open-hearth is the cost above net metallic mixture.

However, if this standard alone is used to determine the efficiency of the open-hearth, the losses involved in conversion are entirely disregarded and may result at times in increased ingot costs, in spite of decreased cost above net metal. While the term “Cost above Net Metal” is generally understood by the steel industry, for purposes of clarity it should be stated that in the discussions involved the cost above net metal embraces all costs incidental to the conversion of any metallic mixture into steel ingots, but excludes the cost of ferro-alloys and the monetary losses involved in the conversion of the charge into ingots. The latter losses would include metalloids eliminated; the metallics lost in slag, in slag pockets, checker chambers, waste gases, etc.; and finally includes losses of material incidental to handling, etc.

The monetary losses represent as much as 40 per cent of the cost above net metal and constitute an important factor in the total ingot cost. Such losses will be represented by the production of scrap, as well as irrecoverable losses, and appreciably affect the ingot yield. Since the cost above net metal ordinarily constitutes only from 15 per cent to 30 per cent of the total ingot cost, it is obvious that any appreciable decrease in yield in turn affecting the cost of the gross and net metallic mixture may offset measurable savings in the cost above net metal.

With the many improvements made in open-hearth practice during the past decade, the cost above net metal has, as a rule, been materially reduced; and this decrease has made the item of “Loss and Additions” of relatively greater importance. While in a large measure the cost above net metal does represent the progress made by an open-hearth plant, the true criterion of its performance may be more accurately indicated by the conversion cost, namely, the difference between total cost of ingots and the cost per ton of metallic charge (alloys excluded).

This paper is devoted to a treatment of the general principles underlying the conversion of metallic charges into basic open-hearth ingots and covers some important factors influencing operating economies. These will include the effect of changes in yields, scrap production, and the possible conversion of some losses into scrap recovery. The influence of types of scrap used and changes in ratios of pig iron and steel scrap is also discussed. Since the influence of changes in type and analysis of pig iron on operating economies has been previously thoroughly covered in a paper by C. L. Kinney, Jr.,1 no discussion of this phase of the metallic charge will be included, nor will any attempt be made to correlate the following to the quality of steel produced, since in any discussions of the metallic charge it is assumed that the slags produced, or the additions used, will be of the character or amount desired to produce the required quality of steel.

Since a variety of conditions, types of steels made, physical limitations, scrap and pig relations will vary from plant to plant, the illustrations fur-

nished in the discussion can be considered only as general principles applying to a definite set of conditions, which must accordingly be revised to suit the conditions existing at individual plants.

In a previous paper entitled "Basic Open-Hearth Yields"2 a method was developed for determining the conditions existing at individual plants.

Table I—Average Slag Analyses

<table>
<thead>
<tr>
<th>Material</th>
<th>SiO₂, per cent</th>
<th>Fe, per cent</th>
<th>Al, per cent</th>
<th>CaO, per cent</th>
<th>MgO, per cent</th>
<th>P₂O₅, per cent</th>
<th>Mn, per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slag (composite)</td>
<td>17.39</td>
<td>6.93</td>
<td>1.59</td>
<td>4.90</td>
<td>8.26</td>
<td>1.28</td>
<td>1.59</td>
</tr>
<tr>
<td>Slag ratio, Fe to Si</td>
<td>1.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table II—Analyses of Materials Used

<table>
<thead>
<tr>
<th>Material</th>
<th>SiO₂, %</th>
<th>Fe, %</th>
<th>Si, %</th>
<th>C, %</th>
<th>Mn, %</th>
<th>P, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig iron</td>
<td>.11</td>
<td>1.12</td>
<td>4.28</td>
<td>1.60</td>
<td></td>
<td>.200</td>
</tr>
<tr>
<td>Steel scrap</td>
<td>.18</td>
<td>.45</td>
<td>.015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ore (natural)</td>
<td>.74</td>
<td>.36</td>
<td>.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>.90</td>
<td>.19</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolomite</td>
<td>.58</td>
<td>.09</td>
<td>.015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluor spar</td>
<td>.15</td>
<td>.59</td>
<td>.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slag (composite)</td>
<td>1.39</td>
<td>8.14</td>
<td>2.89</td>
<td>8.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual in bath</td>
<td>.12</td>
<td></td>
<td></td>
<td>.16</td>
<td>0.015</td>
<td></td>
</tr>
</tbody>
</table>

Table III—Losses in Components of Basic Open-Hearth Charge

<table>
<thead>
<tr>
<th>Loss</th>
<th>Fe in ore, scale, etc</th>
<th>Hot metal or pig iron</th>
<th>Steel scrap</th>
<th>Limestone</th>
<th>Dolomite</th>
<th>Fluor spar</th>
<th>Slag (composite)</th>
<th>Residual in bath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total losses</td>
<td>7.206</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net losses</td>
<td>7.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrap recovered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallics in slag</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total loss and scrap</td>
<td>12.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingot yield</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table IV—Calculation of Basic Open-Hearth Yields

<table>
<thead>
<tr>
<th>Materials used</th>
<th>Fe in ore, scale, etc.</th>
<th>Hot metal or pig iron</th>
<th>Steel scrap</th>
<th>Limestone</th>
<th>Dolomite</th>
<th>Fluor spar</th>
<th>Slag (composite)</th>
<th>Residual in bath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses in charge components, per cent</td>
<td>11.42</td>
<td>2.072</td>
<td>.09</td>
<td>.74</td>
<td>1.46</td>
<td>4.24</td>
<td>7.101</td>
<td>7.206</td>
</tr>
<tr>
<td>Net losses</td>
<td>7.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scrap recovered</td>
<td>4.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metallics in slag</td>
<td>12.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

charge into ingots, the relation between pig iron and steel scrap prices, as well as the effects on other departments of the plant, would largely govern the choice of type of charge to be employed for the usual grades of steel.

The following tables show the method of calculating yields based on the Fe to Si ratio method, in which a minimum amount of information is required for reasonably accurate checks on ingot yields. A typical example is furnished (Tables I to IV) showing the calculation of ingot yields which checks accurately with one year's results obtained at a plant where considerable care was exercised in weighing all materials, ingots, scrap produced, etc. Briefly, this method consists in developing the ratio between the Fe and Si content of the slags produced and calculating the loss contributed by Si or SiO₂ of the various components in the charge which contained Si or SiO₂. The usual metalloid losses are accounted for and in addition an empirical method developed to cover iron losses, such as: losses due to slag in slag pockets; dust in checker chambers, waste gases, etc.; as free metallic iron in slags; due to unrecoverable spillage on floor and pit side, etc.; and other minor losses incidental to ingot production.

The following is an explanation of certain factors in the metallic charge which have a marked effect on operating economies and is offered not as the final answer of the most desirable charge, or practice, but to merely indicate certain phases which may materially affect the ingot cost from an open-hearth standpoint. Whether these hypothetical savings can be obtained at various open-hearth plants will depend on the excellence of the practice em-

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employed and conditions peculiar to the plant in question.

The paper is divided into a treatment of the three well-known methods of converting metallic charges into basic open-hearth ingots, namely, hot metal plants, cold iron plants and duplex plants.

**Hot Metal Plants**

Hot metal plants represent by far the largest part of the ingot producing units in this country and this is the typical method of operation at all modern plants, excepting those that may use the duplex process in its many forms. The use of hot metal makes possible the rapid charging in molten form of large portions of the total charge, and the economies of this method of operation are so self-evident as to require no comment.

Since in any discussion of the effect of the metallic charge on operating economies the matter of yields is of utmost importance, it follows that comparisons of the practice at any plant must be necessarily based on reasonably accurate yields, or at least that the difference in yields be relatively accurate. Such comparisons should be made on the trend of a large number of heats rather than a few special tests, since in the latter case many qualifications must ordinarily be made to take care of abnormal conditions of occurrences, such as accuracy of weighing, delays in charging, variations in analysis of raw materials, bottom conditions, etc.

**Influence of Inaccurate Weighing**—Even though the necessary deduction is made from the blast furnace molten iron for kish content and the material carefully weighed leaving mixer to transfer ladles, or from mixer ladles to transfer ladles—and such transfer ladles light weighed—it will be normally found that adjustments must be made occasionally in order that the total amount of iron charged to the open-hearth furnace will check with that received. In carefully conducted operations the errors which occur are normally not of sufficient magnitude to perceptibly affect the yields, but unless individual tests are most carefully developed a decided difference in yields can readily occur because of skullying, loss in handling, and accuracy of weighing involved.

Even greater inaccuracies can result in determination of yields based on a limited number of tests, due to the very decided differences between charging box scrap weights and broad gauge car weights. For obvious reasons, it is the customary practice to weigh charging buggies in motion. Material weighed in this manner will vary considerably from the same amount of material weighed in broad gauge cars. This factor is of no importance where comparisons of metallic charges and their influence on yields and operating costs are based on extended periods of time, since ordinarily the same variations or errors will occur throughout the comparison, proper inventory adjustments being made.

However, where only a limited number of heats are made with different charges, and particularly different types of scrap, the influence of the differences in weights is of major importance, since not only is there a difference between steel scrap weights in charging boxes as compared to the same material in broad gauge cars, but more important there is a decided difference in the weights of various types of scrap when loaded in charging boxes as compared to broad gauge cars. Table V shows a comparison of composite scrap weights at various plants, showing the relation between buggy weights in motion as against standard gauge car weights.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Standard Car Weights, pounds material</th>
<th>Buggy Weights, pounds material (in motion)</th>
<th>Per cent heavy</th>
<th>Per cent light</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>697,900</td>
<td>682,000</td>
<td>2.28</td>
<td>3.30</td>
</tr>
<tr>
<td>2</td>
<td>1,174,060</td>
<td>1,136,000</td>
<td>1.50</td>
<td>1.01</td>
</tr>
<tr>
<td>3</td>
<td>957,700</td>
<td>958,700</td>
<td>.80</td>
<td>.60</td>
</tr>
<tr>
<td>4</td>
<td>6,066,300</td>
<td>6,159,500</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>5</td>
<td>3,795,700</td>
<td>3,764,300</td>
<td>.01</td>
<td>.01</td>
</tr>
</tbody>
</table>

The following figures (Table VI) illustrate some of the variations which may occur in weights of different types of scrap when loaded in broad gauge cars or buggies. The light weights may be explained to some extent, particularly where pit scrap or mill scrap is handled, due to the scale, slag, etc., adhering to the materials but separating and remaining in broad gauge cars on handling. Naturally, if the broad gauge cars are not light weighed there will be a perceptible difference in the weights of the materials. It is generally understood that scale weights of charging boxes are never 100 per cent accurate and that necessary inventory adjustments are made from time to time. When conclusions are drawn from a selected number of tests, particularly in studying values of different types of scrap, it is necessary that the same basis be used in all weight determinations to assure a valid comparison which is at least relatively accurate.

<table>
<thead>
<tr>
<th>Loaded in Buggies</th>
<th>Per cent light</th>
<th>Per cent heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy scrap unload from stock</td>
<td>1.74</td>
<td>...</td>
</tr>
<tr>
<td>Slab scrap</td>
<td>...</td>
<td>.16</td>
</tr>
<tr>
<td>Rail scrap</td>
<td>...</td>
<td>4.20</td>
</tr>
<tr>
<td>Merchant mill scrap</td>
<td>...</td>
<td>4.01</td>
</tr>
<tr>
<td>Sheet scrap</td>
<td>...</td>
<td>.64</td>
</tr>
<tr>
<td>Tin bar scrap</td>
<td>...</td>
<td>2.40</td>
</tr>
<tr>
<td>Sheet bar scrap</td>
<td>...</td>
<td>3.10</td>
</tr>
<tr>
<td>Pit scrap</td>
<td>...</td>
<td>3.30</td>
</tr>
</tbody>
</table>

**Influence of Open-Hearth Scrap Production on Operating Economies**

Table IV shows the results obtained from certain pig iron charges over a period of a year at one plant, resulting in the following ingot production, scrap, and loss:
<table>
<thead>
<tr>
<th></th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingot yield</td>
<td>87.99</td>
</tr>
<tr>
<td>Total scrap produced</td>
<td>4.80</td>
</tr>
<tr>
<td>Loss</td>
<td>7.21</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

From the foregoing, it is apparent that the ingot yield for any given charge and the same type of steels produced will vary in accordance with two factors, namely, (1) the amount of scrap produced, (2) the loss. It is obvious that the total scrap could be reduced by increasing the loss but this would be a monetary waste since it would mean an imperfect recovery of scrap. On the other hand, at any well conducted plant where definite limestone charges are required to produce various types of steels, and thus resulting in a definite type of slag, the losses are more likely to be less amenable to reduction than the production of scrap.

In the production of ingots at any open-hearth plant operating with hot metal there are many steps in the operation which produce scrap, among the more important being:

(a) Iron skulls and iron scrap produced in the handling of iron to and from the mixer, or mixer ladles, to the open-hearth furnaces.
(b) Steel skulls produced in steel pouring ladles.
(c) Pit scrap, including runner scrap, monkeys, ladle over-flows, scrap due to bottom conditions and draining furnace, metal lost in flushing run-off slags, scrap due to running stoppers, etc.
(d) Condemned ingots and ingot butts.

(To be continued)

**Metallurgical Advisory Board Meets At Pittsburgh, Pa.**

The fifth annual open meeting of the metallurgical advisory board to the Carnegie Institute of Technology and the U. S. Bureau of Mines was held on Friday, October 16, on the Carnegie Tech campus, Pittsburgh.

Progress made on research problems undertaken jointly by Carnegie and the Bureau of Mines was discussed during the morning and afternoon sessions by investigators from the two laboratories.

Mr. Charles F. Abbott, executive director of the American Institute of Steel Construction, Inc., was the principal speaker at the evening session which was followed by an informal dinner at the Hotel Schenley. Mr. Abbott’s subject was “Market Research in the Steel Industry.” Dr. Thomas S. Baker, president of the Carnegie Institute of Technology and organizer of the advisory board, presided at the evening session.

The morning meeting was devoted to reports and discussions on iron-manganese-carbon alloys and chrome-nickel alloys. Reports on research work were given by Dr. Francis M. Walters, Jr., director of the Bureau of Metallurgical Research; Dr. V. N. Krivobok, metallurgist of the same bureau; and Maxwell Gensamer and Cyril Wells, assistants. Dr. C. H. Herty, Jr., physical chemist, and M. B. Royer, assistant metallurgist, of the Bureau of Mines, delivered a report on the solubility of carbon in iron-manganese-silicon alloys. Dr. G. R. Fritterer, associate metallurgist of the Bureau of Mines reported on the electrolytic method for the determination of inclusions in steel.

The physical chemistry of steel making was reported on and discussed at the afternoon session. The three outstanding contributions from this work are the development of a new manganese-silicon deoxidizer, which has been shown to be much superior to ferro-manganese ferro-silicon in combination in producing clean steel at a low cost; the development of a method for quantitatively determining non-metallic inclusions in plain-carbon steels; and the determination of the factors which affect the oxidation of steel in the open-hearth furnace. These reports were made by Dr. Herty and members of the Bureau of Mines staff.

The several reports were interspersed with discussions by metallurgists from the industry.

The laboratories of the Bureau of Mines and of the Carnegie Institute of Technology were open for inspection. Members of the staffs were present for informal discussions on work being done.

**September Steel Output Increases**

During the first 25 days of September the smelters of the United Steel Industry produced 261,000 metric tons of pig iron, or 3 per cent more than in August. Their production of steel ingots amounted to 198,000 tons, or 11 per cent above the figure for August.

**The Bessemer Process and Its Product**

(Continued from page 1450)

the first but with the large increase of blast volume at end of blow, “spit” badly.

These special blows, which illustrate the blast volume and blast pressure changes during a Bessemer heat, also demonstrate a fact that is extremely important in its effect on product uniformity and quality. A chemical change in the molten metal bath can be noted practically the instant it occurs by means of the pressure gauge; such changes are indicated by the points A and B in Fig. 2. The instant they are noted, a change can be made in the rate at which oxygen, the chemical reagent, is added by increase or decrease of blast pressure or volume or both, and this change of rate can be made in a few seconds.

(To be continued)
New Billet and Rod Mills

at the Donora Steel Works

Improvements and additions to the Donora plants of the American Steel & Wire Company which were announced and authorized a year ago have now been completed and are in successful operation. The improvements consist of a new continuous billet mill for the Donora steel works, and two new double line continuous rod mills for the Donora wire works, together with auxiliary equipment.

The Donora plants are located on the Monongahela River at Donora, Pa., which is about 30 miles from Pittsburgh, Pa. They occupy a river frontage of approximately four miles.

The Monongahela River is improved with locks and dams to the Ohio River, and these, with the completion of the canalization of the Ohio River from Pittsburgh to the Mississippi River, provides water transportation every day in the year from the Donora mills to all points on the great waterways mentioned. Water transportation, therefore, supplements the railroads in serving these plants.

One Continuous Billet Mill

The new 10-pass continuous billet mill takes a 7½ in. square bloom and reduces it to a 2 in. x 2 in. x 30 ft. billet. The 7½ in. square bloom, supplied to the billet mill by a 40-in. blooming mill, is cropped and cut to the correct length by a steam-driven down-cut shear. On one side of the shear is a depressing table, recently installed, which prevents the bending of the bloom during the process of shearing. A transfer table conveys the bloom to the power-driven feed rolls in front of the 24-in. mill. A new slab transfer table has been installed near the depressing table so that when the blooming mill is running on slabs they can be conveyed to cars located on a depressed track.

Heretofore the smallest billet rolled by the steel works was 4 in. x 4 in. In order to take care of the rolling of 4 in. x 4 in. billets in addition to the 2 in. x 2 in. billets, it was necessary to make this continuous billet mill flexible enough to take care of both sizes. The first six passes of the billet mill, therefore, consist of a 24-in. train of rolls which reduce the bloom to a 4 in. x 4 in. billet. This billet can be reduced further by four passes of rolls 18 in. in diameter to a 2 in. x 2 in. billet, or it can be transferred to a roller feed table which feeds the billet into a power shear to be cut into standard lengths of 4 in. x 4 in. billets.

A flying shear is located at the proper distance from the continuous billet mill for cutting 2 in. x 2 in. billets to the right length. Power-driven rollers and a skew table are used to separate the billets, if it is necessary to do so, in accordance with that part of the ingot from which they came. They can...
Fig. 1 (Left)—A portion of the cooling tables delivering billets onto the power-operated transfer buggy—Billet yard in background. Fig. 2 (Center)—Continuous rod mill billet heating furnace. Fig. 3 (Right)—Continuous rod mill showing the 8-pass roughing mill.

be placed on any of three separate cooling tables, each of approximate capacity of 450 tons of billets. Each cooling table is equipped with a power-driven straight edge which removes the billet from the entering table to the cooling tables. Billets are transferred from cooling tables to an electrically operated billet transfer car which conveys them to the billet yard of the continuous rod mills.

**Lubrication**—All gears are thoroughly encased and, together with the bearings, are lubricated by a continuous circulating stream of oil; the oil is returned by means of proper collectors to the filtering system, by means of which it is purified and maintained at a uniform temperature.

**Motor Room**—In the motor room of the billet mill, located next to the continuous billet mill, are housed the electrical switchboards and two large motors, which drive the mill, speed reducers, and encased gear drives. This motor room is equipped with a large ventilating fan which blows filtered air around the motors and motor generating sets. The fan also keeps up a room pressure which prevents any outside dust from coming in.

**Control Stations**—The continuous billet mill and auxiliary equipment is operated from four control stations. The one at the 24-in. mill operates bloom transfer table, slab transfer table, and approach table to the 24-in. mill.

The second control station is located between the 24-in. and 18-in. mills and operates the intermediate table, the crop shear, the 4 in. x 4 in. billet transfer table, and the two large motors operating the entire mill.

The third control station operates the flying shear, run-out table from the flying shear, the skew tables and the billet retarder.

The fourth station operates the cooling tables and the loading of the transfer buggy.

This is one of the highest-speed billet mills in the United States, and has capacity sufficient to roll 130 gross tons of billets per hour.

**Two Continuous Rod Mills**

When designing and installing two continuous rod mills, many novel and interesting features were embodied, which will be brought out in the following description:

**Billet Yard**—The standard billet is 2 in. x 2 in. x 30 ft. long and weighs approximately 400 lb.; how-
ever variations in size either under or over, or in length under 32 ft. can be obtained according to orders received. The billet yard is covered by two 15-ton electric traveling cranes with 115-ft. span, which lift the billets from the buggy that travels from the cooling tables to the billet yard. The cranes can place billets either in stock or carry them to the mills direct, or can take them from stock to the mills. By suitable racks the grades of steel are kept separate. Each rack is numbered and the steel substantially and suitably marked so as to prevent any mixing of grades. A stock of over 12,000 tons can be carried at all times, which is sufficiently large to permit the immediate rolling of orders for the most urgent customer.

The two rod mills are alike, with the exception that one is right-handed, and the other left-handed, with the operating side of the mills facing each other. Each rod mill is equipped with a loading skid directly under the billet yard crane, and is supplied with billets by means of the crane. An approach table leads from this skid to the furnaces.

Furnace—The furnace, of modern design with a flat arch, is at present being fired by natural gas. It is completely equipped with a preheater, automatic air control, and other automatic regulators. The billets are pushed into the side of the furnace by a pinch roll and down the hearth by suitable arms operating from an electric pusher. By a suitable push-out mechanism, the billets are fed directly to the first set of rolls of the continuous rod mills.

Each continuous rod mill consists of 18 sets of rolls, which by a suitable arrangement of roll sizes and increase in speed, take care of the elongation of the bar. Particular care was taken in designing the mill. The bed plates, rugged and substantial in design, consists of one piece for the finishing mill and one piece for the roughing mill. The housings are also substantial, accessible, and adjustable for easy regulation of the mill. The rod passes from

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**Fig. 4 (Left)—General view of continuous rod mills. Fig. 5 (Right)—Operating pulpit in which is equipment to operate**

**Main motor—Reels in foreground—Rod conveyors in background**
the finishing stand of rolls to the revolving reels. In order to guard against break-downs and interrup
tion of production, each mill is supplied with two conveyors and six reels. By suitable mechanism the rod can be switched to any one of three reels. The reels are of heavy construction; each one is driven by its own motor and completely equipped with automatic controlling devices. From the reels the coil of rods is pushed off onto a suitable rod conveyor which carries the rods away from the mill and delivers them finally on a hook-type conveyor. This conveyor provides uniform cooling and conveys the rods either to the storage building, cleaning house, or to the shipping tracks.

The two continuous rod mills are housed in a pair of twin buildings, each approximately 72 ft. wide by 386 ft. long. The buildings were designed, fabricated, and erected by the American Bridge Company. Each is of heavy construction, equipped with mechanically operated ventilating sash on side walls and in monitors. The monitors and belts of glass in the side walls are so placed that the lighting is uniform. Inside, the building is painted with aluminum paint with a black border 6 ft. high. The side walls are made so that the lower 10 ft. are removable. The floors are designed for heavy traffic and are covered throughout with suitable plates and other substantial flooring.

Lubrication—Both rod mills are thoroughly equipped with separate oiling systems, complete with the necessary filters and thermostatic control to maintain uniform temperature. All pinions and gears operate under a continuous flow of oil and all bearings have suitable wipers on the shaft, together with proper collectors and returns so that the oil is properly returned to the oiling system. The lubricating system is provided with pumps to keep the oil constantly in circulation. The units in the oiling system are tied up in such a manner that a break-down in any part of the system will not in any way interfere with the production of the mill, moreover, all pumps, etc., are of sufficient capacity to take care of the situation. All gears are thoroughly encased and covered, and to show how well the mill was constructed, there has been no oil lost during four month’s operation.

Safety—In designing the mills, extreme care was taken to conform to all the safety standards which have been accepted throughout the industry. All revolving shafts were covered; solid cases enclose all gears; there is automatic lubrication through all mills; screens were erected between the mills, back of the mills, and to guard all passageways so that workmen will not be injured by flying rods.

Pulpit Control—For the operation of each mill, a pulpit with suitable devices was erected in such a place that all operations of the mill are visible. From this pulpit, control tables operate the main motor for the continuous mill, motors for the reels, rod conveyors, and other mechanism connected with the reels.

Electrical Apparatus—Power is received at the outdoor substation at 25,000 volts and is transformed down to 6600 volts for the main motors of all mills.

General

The tendency of the trade has been toward the use of heavier-weight bundles, both of wire and of rods; consequently, improvements were made to meet this demand and also to anticipate future requirements along this line as regards the manufacture of still heavier bundles. The use of heavier-weight bundles of rods or wire naturally results in decreased manufacturing cost of finished products, owing to greater machine efficiency and to a lesser amount of scrap. The new continuous rod mills furnish better rolled rods truer to shape and to gage than those rolled on a Garrett rod mill. The desired physical properties and uniform structure throughout the coil of rods are readily obtained from these mills.

The annual capacity of the two continuous rod mills is about 200,000 tons of rods, ranging in size from No. 5 to 5/16 in. inclusive.

Steelmakers Are Optimistic

(Continued from page 1447)

Magnetic Materials in the Year 1931, by Dr. T. D. Yensen, research engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.; and

Factors That Affect the Welding Qualities of Steel, by Wilmer E. Stine, research engineer, The Lincoln Electric Company, Cleveland, O.

At the banquet in the evening Mr. Farrell delivered his address. Other speakers were Fritz Thysen, German industrialist, and Walter D. Hines, formerly director general of the Federal railroad administration. Frank Newman Speller was presented by Mr. Schwab with the institute’s bronze medal for the best paper delivered at last year’s meeting.
Successful Open-Hearth Operation with Coke Oven Gas

By A. J. EBNER
Mechanical Engineer
Freyn Engineering Company

The modern open-hearth furnace retains to a remarkable degree the general principles of design and form of furnace as originally developed by Siemens. While there have been attempts to depart radically from the line of normal development, these have proved beneficial only in a negative sense by showing what should be avoided. The low thermal efficiency of the furnace has been the lure to attract a multitude of ill-advised and costly experiments, which, in some cases, succeeded in accomplishing their desired primary object of fuel economy, but nevertheless were failures owing to a consequent rise in furnace maintenance costs or decreased production rates and yields. Real improvements in furnace design have been along the lines of gradual refinement of the various parts, resulting from better understanding of the limitations imposed by this highly specialized process.

A typical case where open-hearth furnace operation has been carefully supervised and furnace design rationally improved is the Hoesch Steelworks at Dortmund, Germany. The furnaces at this plant show a very creditable performance record not only in fuel economy but in maintenance costs and yields.

It is noteworthy that the fuel burned in these furnaces is straight coke-oven gas, which, in the experience of many other plants, has been burned with difficulty. Coke-oven gas has been used in German steel plants for many years, but it had generally been necessary to use some tar as auxiliary fuel. Furnaces on coke-oven gas were difficult to operate, and in fuel economy and maintenance were inferior to those operating on mixed gas fuel. The light coke-oven gas had a tendency to rise to the roof of the furnace, and also produced a hot non-luminous flame that was not easily controlled. The trouble was aggravated still more by increasing debenzolization of the coke gas which resulted in further lack of luminosity in the furnace flame. It was under these conditions that the Hoesch furnace has been successfully developed and the plant of its sponsors is now recognized as an outstanding example of excellent furnace practice.

Hoesch Furnaces

At Hoesch the open-hearth shop comprises a total of nine furnaces, five of which are 30-ton units, three of 100-ton and one of 150-ton capacity. All are stationary furnaces except the 150-ton, which is the tilting type. The furnaces are similar with reference to the form of regenerators, slag pockets, uptakes, ports and gas burners, which, in combination, are the essence of the Hoesch improved design.

The design of this furnace is illustrated in Fig. 2. As may be seen from inspection of this illustration, the slag pockets have the same width as regenerator chambers and both are built with center dividing wall and double arched roofs. The slag pocket is thus of large capacity. A single uptake tapers from a wide opening centrally over the slag pocket, narrowing as it rises to the furnace port, the latter being ideally simple, compact and removable. A double burner, as shown in Figs. 1 and 3, is provided at each furnace end, each burner receiving gas through a water-sealed gooseneck which permits easy adjustment of burner positions.

The arrangements of single air uptake and short furnace head with constricted port produce a high air velocity concentrated at the point of admixture with the gas and results in exceptionally good turbulence and effective flame.

Because of the form and location of the uptake, sufficient velocity of the air is obtained at the port without undue friction and eddy current losses. In addition, the tapering of the duct lends itself effectively to segregation of the slag, and has the virtue of being self-cleaning.
The normal operating fuel consumption for the group of nine furnaces amounts to from 9,300 to 10,400 cu. ft. of coke-oven gas per gross ton of steel produced, the gas having a higher heat value of 527 B.t.u. per cu. ft. These figures cover the full range of production of the shop and include all gas used on the furnaces throughout the entire campaign and without deductions for lost time, Sunday gas or other reasons. Gas consumption based on actual time of heats from tap to tap on all nine furnaces averages 8,390 cu. ft. per ton, or a heat input of about 4,400,000 B.t.u. per ton of steel.

Average Figures

The foregoing figures on fuel consumption are not submitted as records over a short period of time or for a particular furnace dressed up for an exhibition run. They represent average shop practice on charges consisting of 75 per cent scrap and 25 per cent iron, of which approximately 85 per cent
of the heats use hot metal and the remainder cold pig. It should further be explained that the furnaces are old and do not have the advantages of modern structural improvements to maintain furnace tightness and stability. The regenerators are not insulated and door and valve equipment are inferior to that used in an average American installation.

The customary German measure of furnace maintenance values is quoted in "bricks used per ton of steel produced." At Hoesch the average of all furnaces amounts to 24-lb. brick per ton of steel inclusive of clay, silica, chrome and magnesite, which is a low figure in comparison with other plants of similar character. Water cooling of doors, frames and ports requires an average of 1,580 gal. per ton of steel. The three 100-ton furnaces are regularly on 110 to 120-ton heats, making 3.3 heats per day, or at an average production rate of 153/4 tons per hour. The hearth load at this production amounts to 68 lb. per sq. ft. per hr. Their practice requires renewal of checker brick after a period of 1,200 heats, and on the group of nine furnaces they have an availability factor of 90 per cent.

Other Plants Use Hoesch Type

Heat input has averaged 4,600,000 B.t.u. per ton of steel thus far, which compares with 6,900,000 B.t.u. per ton with the previous furnace on producer gas. This plant is now changing the remaining furnaces of the shop over to the Hoesch design. Another large plant in the Saar district has also adopted the Hoesch furnace in changing over from mixed gas to coke-oven gas alone. They report faster heats, hotter steel and lower heat consumption since the change in furnace type and fuel; they also have reduced refractory loss to 24 lb. per ton of steel from their previous average of 46 lb.

Patents have been granted on this furnace design and the improvements which are the essence of the design in European countries. Patents are pending in the United States and Canada. Freyn Engineering Company is prepared to furnish designs and a license to use such designs on open-hearth plants in North America.

Harry J. Fisher, Made Manager of Sales of the Aetna-Standard Engineering Company

HARRY J. FISHER, formerly with The Reliance Electric & Engineering Company as sales manager, will on November 2 take over the position of manager of sales with the Aetna-Standard Engineering Company of Youngstown.

Mr. Fisher's entire business career has been in the line of selling and sales engineering to the steel plants of the United States and Canada.

Upon his graduation from the University of Michigan with the engineering class of 1913, and following an apprenticeship of a few years with The Electric Controller & Manufacturing Company, he entered the selling field with that organization as a sales agent in the Pittsburgh district.

In the year 1917, Mr. Fisher entered the employ of The Reliance Electric & Engineering Company and at that time, in the capacity of manager of the Pittsburgh district, opened the Pittsburgh sales office of that company in which position he continued until 1919 at which time he was transferred to the Cleveland office and three years later placed in charge of steel mill sales throughout the United States and Canada.

Mr. Fisher has been instrumental in the development of numerous steel plant improvements, the application of electric motors to wire blocks and the development of the individually driven table roller being two of his many interests.
efficiency of

Blast Furnace Gas

Disintegrators

DR. I. N. GOFF and T. S. WASHBURN

The object of this investigation was to determine the efficiencies of two types of gas disintegrator cleaners recently installed in the Chicago district. These are being used for the final cleaning of blast furnace gas after it has passed through the towers. Disintegrators and towers are of the Brassert type.

Method

The gas samples were taken from No. 2 clean gas main at a point on a straight section. This point was about 55 ft. beyond the elbow leading up from the disintegrators, so that there should be a uniform flow of gas across the section (a straight stretch of pipe, 10 diameters or more in length, is usually considered sufficient to avoid turbulence).

The velocity and flow data for the cross-section of pipe where the sampling was done was determined in a preliminary set of experiments. These data were used in the present report to calculate the relation between the center and average velocities, and the volume of gas passing through the main.

The samples for dust analysis were obtained by drawing the gas from the center of the main with a glass tube and passing it through a filter, which collected the dust. The gas then went through a meter, which measured the total volume and the rate of flow. A rotary pump was placed in the circuit between the filter and meter to control the flow. A pitot tube, static tube, and thermometer were placed about 6 ft. below the point where the sample was being taken, to obtain the data on the velocity and volume of the gas in the main.

The sampling tube and pitot tube were placed at the center of the main, 22½ in. from the wall, where the dust content of the gas should approximate the average. In order to prevent any settling of dust in the sampling tube the velocity of the gas drawn through the tube was kept equal to that of the gas in the main.

Most of the determinations were made on 200 cu. ft. of gas, collected over a period of about an hour and a half. During this time the flow of gas through the disintegrator, and the water flow, were kept constant.

A description of the apparatus used for this determination is given below:

1—Sampling tube. 36 in. long with a right angle at one end bent to a 10-in. radius. The tube was made of gage glass—¾ in. inside diameter and ¾ in. wall thickness.
2—Brady dust sampling equipment — consisting of a filter holder, a circular furnace, dust filters, and weighing flasks.
3—Vernon Rotary Compressor. Made by L. S. Smith and Son. Driven by a 3½-hp., 1725 r.p.m. Westinghouse motor.
4—Dry gas meter—5 cu. ft. per minute capacity. Made by American Gas Meter Company.
5—Pitot tube and differential gage reading to 0.01 in.
6—Static tube.
7—Two thermometers—for main and meter.
8—Barometer.

Calculations

(A) Relation between velocity in main and flow through meter.

\[ Q = 60 \times A \times V_g \]

Where \( Q \) = cubic feet per minute through meter
\( A \) = cross-sectional area of sampling tube
\( V_g \) = velocity of gas in main—cu. ft./sec.
For a ½-in. sampling tube (inside diameter)

\[
Q = 60 \times \frac{\pi \times (0.03125)^2}{4} \times Vg
\]

\[
= 0.0460 \times Vg = 0.0460 \times \sqrt{2gh}
\]

\[
= 0.0460 \times \sqrt{2g \times 4.34 \times \frac{X}{W'g}}
\]

\[
= 0.0460 \times 10.72 \sqrt{\frac{X}{W'g}} = 0.769 \sqrt{\frac{X}{W'g}}
\]

Where \( X \) = pitot tube reading (inch of oil)

\( W'g \) = weight in pounds per cubic foot of gas

under conditions of temperature and pressure in main.

\[ W'g = Wg \times V = 0.07790 \times \frac{520}{30.0} \times \frac{P_1}{T_1} \]

\[ = 1.35 \times \frac{P_1}{T_1} \]

\[ Q = 0.769 \sqrt{\frac{1}{1.35} \times \frac{XT_1}{P_1}} \]

\[ = 0.662 \sqrt{\frac{XT_1}{P_1} \log_{10} 0.662} = 9.820963 \]

where \( T_1 \) and \( P_1 \) = temperature and pressure in main.

The curves for this equation with several values of temperature and pressure are shown in the illustration on page 1466. These were used during the running of a test to determine the rate of flow through the meter which would give the same velocity of gas in the sampling tube as in the main. A further correction must be made to these values, however, if the meter varies much from standard conditions of temperature and pressure.

(B) Velocity at center of main

\[ V'_1 = 16.72 \sqrt{\frac{X}{W'g}} = 16.72 \sqrt{\frac{1}{1.35} \times \frac{XT_1}{P_1}} \]

\[ = 14.39 \sqrt{\frac{XT_1}{P_1} \log_{10} 14.39} = 1.157979 \text{ ft./sec.} \]

where \( X \) = pitot tube reading (inch of oil)

\( T_1 \) = temperature of gas in main (deg. abs. F.)

\( P_1 \) = pressure in main (inch of Hg)

= barometric pressure + .074 \times inch water in static tube.

(C) Volume of gas, in cubic feet per minute, flowing through main.

\[ Q'_1 = 60 \times C \times A \times V'_1 \]

Where \( Q'_1 \) = volume of gas flowing at temperature and pressure in main.

\[ V'_1 = \text{velocity at center of main (ft./sec.)} \]

\( C \) = ratio of average velocity in main to velocity at the center, as determined in the preliminary experiments.

\[ = 0.9115 \]

\( A \) = cross-section area of pipe.

\[ Q'_1 = 60 \times 0.9115 \times 11.045 \times V'_1 \]

\[ = 60.40 \times V'_1 \]

Fig. 1—Disintegrator of the three bar type
\[ Q_1 = Q'_1 \times \frac{P_1}{P} \times \frac{T}{T_1} \]

Where \( Q_1 \) = volume of gas under blast furnace standard conditions

\[ P_1 = \text{pressure in main (inch Hg)} \]

\[ P = \text{blast furnace standard pressure} = 30.00 \text{ in. Hg} \]

\[ T_1 = \text{temperature in main (abs. deg. F.)} \]

\[ T = \text{blast furnace standard temperature} = 520 \text{ deg. abs.} \]

\[ Q_1 = 60.40 \times \frac{520}{30.0} \times \frac{P_1}{T_1} \times V'_2 \]

Data covering the operation of the disintegrator were collected while the tests were being run. The total volume of gas passing through the disintegrator was the sum of the gas passing through two clean gas mains. The power was computed from the average amperes. The water flow was taken as the average meter reading during the run, except on the last three tests where the difference of the integrator readings divided by the time was used.

The manner in which the data from each experiment were itemized and calculated is shown in the computation on the seventh run on page 1465.

Data taken on eight of the thirteen tests made are given in Table I. The other five tests were not used in this report due to factors during the run, such as an incorrect rate of flow or poor collection of dust in the filters, which indicated a probable error in the results. The velocities, volumes, and dust contents shown in the table are all corrected.
to blast furnace standard conditions (60 deg. F. and 30.00 Hg).

Tests Nos. 5 and 7 were made on No. 1 disintegrator, which is a 4-bar type. Tests Nos. 8 to 13 were on No. 2 disintegrator, (Fig. 1) which is a 3-bar type.

Chemical analyses were made of the dust collected from four of the runs. The results are shown in Table II. The samples from runs Nos. 10 and 11 were washed with water, and consequently no accurate determinations for CaO and MgO could be made on these. The difference between the sum of the compounds shown and 100 per cent is considered to be made up of carbon, sulphur, and the alkalies (Na₂O and K₂O). These elements and compounds could not be satisfactorily determined on such small samples of dust, especially when tightly adhering to paper thimbles. An estimation, however, indicates that the sum of the sulphur and carbon is from two to three per cent—the balance probably consisting of the two alkalies, Na₂O and K₂O. This estimation was made from previous analyses on the dust collected from gas after it had passed through a Feld Washer.

**Summary**

Thirteen tests were made to determine the efficiencies of the two types of disintegrator gas clean-
gas cleanliness while the horsepower is comparable to that of the 3-bar machine.

The minimum dust content obtained with the 3-bar type of disintegrator is 0.002 grains per cu. ft.

greater than with the 4-bar type. The 3-bar type uses approximately 68 gal./min. more water and 120 less hp. when operating with a water flow that gives the minimum dust content.

The six tests on the 3-bar type indicate that there is an ideal water flow, above or below which the dust content increases. The minimum dust content was obtained with a flow of 225 gal. a min.

A chemical analysis of the dust collected from four of the runs gave the following average analysis:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>21.86</td>
<td></td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>8.11</td>
<td></td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>17.16</td>
<td></td>
</tr>
<tr>
<td>CaO</td>
<td>27.74</td>
<td></td>
</tr>
<tr>
<td>MgO</td>
<td>5.36</td>
<td></td>
</tr>
<tr>
<td>MnO</td>
<td>1.47</td>
<td></td>
</tr>
<tr>
<td>Carbon, sulphur and alkalies</td>
<td>15.62</td>
<td></td>
</tr>
</tbody>
</table>

There was apparently no relation between the composition of the dust and the cleanliness of the gas.

According to the above data, the dust delivered by the gas to a stove, assuming 4300 cu. ft. of gas per min. containing 0.012 grains per cu. ft., equals 10.615 lb. a day or 314 lb. a year. The extreme fineness of this dust favors its being carried through with the stack gases.

The STORY OF STEEL,” from the mining of iron ore to the manufacture of finished steel products, is depicted interestingly in a series of educational motion pictures just released for free circulation by the United States Bureau of Mines, Department of Commerce. These motion pictures, which constitute a notable addition to the bureau’s extensive collection of films that visualize the workings of American mineral industries, have resulted from extensive revision of a picture prepared some years ago. They have been produced by the bureau in cooperation with an industrial concern, and are available on both 35 and 16 millimeter width of stock.

Film 143, two reels, “Mining and Metallurgy,” shows the geographical and geological location of the iron ore deposits; transportation of ore from mine to blast furnace by boat and railway; reduction of the ore in the blast furnace to pig iron or molten iron for further processing in Bessemer, open hearth or electric furnaces; and the pouring of ingots, weighing two to four tons, from which steel products are made. It also shows the making of coke in by-product ovens.

Film 144, one reel, “Rails, Rods, and Plates,” shows the method of making these and other hot rolled products from the ingots. Educational, athletic and social activities are pictured.

Film 145, one reel, is titled “Wire Products.” First the rods, the rolling of which was shown in film 144, are rolled to a smaller diameter and then, after exposure to acid and other baths, are cold drawn through tapering holes of successively smaller diameters until ready for making into barbed wire or other fence, or making into rope, nails or other wire products. Playground activities are shown.

Film 146, one reel, “The Manufacture of Pipe,” includes the following: Heating and rolling two to four-ton ingots, cutting into lengths, and rolling to a suitable length, thickness and width for the desired pipe. The edges are beveled and the skelp is rolled to a circular cross section. It is then reheated to a welding heat, pushed from the furnace into the lap-welding rolls with a ball mandrel on the inside to act as an anvil.

Film 147, one reel, bears the title “Sheets and Tin Plates.” This process consists primarily of rolling a suitable sized bar flat, doubling it, reheating and rerolling and redoubling until the pack is eight sheets thick. After this pack is rolled down to the proper thickness, it is trimmed, and the sheets are tinned or galvanized.
Hair Cracks

On the Surface of Sheets

PART V

By ERICH A. MATEJKA
Dipl. Engr., Witskowitz

A piece from the cross section through the long axis of ingot 1 showed a rather deep blowhole zone and the sound walls showed solidification pores dispersed inside. Sections through the long axis of ingot 2 heated in the reheating furnace also show that the edge parts were developed as usual.

With the bloom from the third test ingot, which showed surface cracks on roughing, the test pieces were also taken at places corresponding to the upper and lower parts of the ingot. Here also nothing extraordinary could be seen in the edge portions. A test-piece was taken from the lower end of the ingot. It shows plainly the direct cracking of the surface at various places without the reason for this formation being given by the character of the immediate vicinity of the crack. As was stated before, this appearance of the cracks and their immediate vicinity, so to speak, represent indirect proof that the cracking of the outermost surface of the ingot might be in no fixed relation with the quality of the material. In other words, do not blame the quality for the cracking of the surface, but blame an overstressing of the material.

Heat 323 (0.17 per cent C, 0.53 per cent Mn, 0.42 per cent P, 0.016 per cent S, 45.7 kg. strength and 21.5 per cent elongation)—in the description of the test for the effect of the shape of mold on the appearance of the defect, we reported on this heat. The ingot was covered with two equally thick layers of scale, one of which has split off partially so that only isolated scaly remnants are seen. Fig. 22 shows the surface of a bloom from a rectangular ingot X; the cracks are seen plainly.

Fig. 24 is a section perpendicular to the surface of the bloom from ingot III. The edge corresponding to Fig. 22 is perfectly flat. Figs. 24 and 25 are the same sections with the bloom from ingot X. Here the edge is cracked and the cracks partially rolled together, are filled with oxides.

Heat 606 (0.09 per cent C, 0.46 per cent Mn, 0.030 per cent P, 0.051 per cent S, 39.1 kg. strength and 25.5 per cent elongation).

The Effect of Oxygen

During the previous discussion, repeated mention was made of the great importance of the oxygen content of the steel, on its hot workability.

The oxides in the iron are necessary for the refining method. In spite of the great protective action of the deoxidation agents, it is very difficult in plant operation not to oxidize more iron than is absolutely necessary, that is, to avoid over-refining of the steel.

It is assumed that oxygen must be regarded as the cause of red-shortness. Thus for example, Ledebur has already pointed out that an oxygen content of 0.1 per cent causes red-shortness. A. Wimmer also assumes a bed effect of oxygen on the technical properties of the iron and gives 0.13 per cent oxygen as the limit of red-shortness. On the other hand, Oberhoffer and d’Huart found that 0.14 per cent oxygen as iron-oxygen does not result in red-shortness. This is also confirmed by the data of Wesley Austin according to which with 0.24 per cent oxygen can be forged and rolled. At any rate, there is deterioration at a rolling temperature of 900 deg. Above and below this temperature it could not be determined. Becker believes that an iron-sulphur-oxygen eutectic can be assumed to be the main cause of red-shortness. This eutectic forms at red heat due to the taking up of oxygen by the iron sulphide, and therefore this red-shortness cannot be removed by deoxidation agents.

According to the investigations of Comstock the iron oxygen compounds are plastic and therefore not so very injurious as are the aluminum oxide inclusions, which do not have these properties.

As Oberhoffer found good forging properties on samples of Thomas iron taken either before or after deoxidation, and according to Monden the poor rolling quality is not only because of oxygen, it must be assumed that the question of the harmful effect of oxygen is not yet completely explained.
Under such circumstances it would be desirable to investigate the relations between the oxygen content of the heats and their behavior on hot working; that is, the appearance of surface cracks. Unfortunately, with the arrangements available it was not possible to carry out these investigations to the desired extent. But, on the basis of previous determinations it can be stated that no difference could be found between the oxygen contents of the sound and cracked sheets. This is also included in the previous considerations in which it was stated that the defect appeared neither in melting nor on making an ingot.

**Summation of the Results of the Main Experiment**

If we arrange the results of the main experiment according to the effect of the individual processes or materials that were investigated, we can divide them into two groups:

1. Those that only favor the appearance of the defect;
2. Those that cause the formation of the defect.

The following influences during the production of the steel belong in the first group:

1. Low manganese content of the heat before tapping,
2. Melting time too short,
3. Higher strength of the steel,
4. Viscosity of the steel on pouring,
5. In the mold:
   (a) wall thickness too great
   (b) small radius of curvature of the edges.

6. Shallow position of the blowhole rings.

The following influences during the work of the steel belong in the second group:

1. Method of preheating,
2. Rolling temperature,
3. Rolling pressure,
4. The cooling water, with certain restrictions.

As stated, the influences in the first group only favor the appearance of the defect but do not cause it, because it was not successful in influencing the crack formation or its avoidance by precautions taken during the production of the steel. We shall take up later how the influencing of the appearance of the cracks can be explained by the given components in the production.

But the results of the experiments concerning the working of the steel show that the cause of the defect should be sought during this part of the manufacture of the sheets. This is even more pertinent because it was possible to arbitrarily influence the formation of the surface cracks.

**Explanation of the Cause of the Defect**

According to the above considerations the appearance of the defect can be influenced arbitrarily only by partial processes during the working of the steel. Therefore it should not be a defect in the material, but primarily a defect in the working. In the following we shall attempt to give a cause of the defect that is in agreement with the processes in hot-working.

We first have the question—How does plastic de-
formation take place? What is plasticity? On what does the deforming property depend?

Plasticity and brittleness are not properties of the material that are determinative for a given material under all circumstances. The same material can be brittle under one type of load and be plastic under another. According to Ludwik, the deformability of a material depends essentially on the temperature and on the rate of applying the load. Accordingly, these must be tested first of all as to their effect during deformation by hot-working or the formation of surface cracks.

Every permanent deformation consists of an elastic and a plastic process, so that every plastic deformation must precede an elastic deformation, be this ever so small. According to Mohr, permanent deformation sets in when the difference between two main stresses perpendicular to each other reaches the magnitude of the deformation resistance. Accordingly, every material offers a certain resistance to its deformation because of internal friction. Internal friction is designated at the force that must be applied to cause permanent displacement of two adjacent particles without removing internal cohesion. With plastic substances this cohesion is greater than internal friction so that there is a displacement of the particles after overcoming it. Every plastic deformation consists of this proportional displacement of the particles, and also of a deformation of the individual crystal grains of which the material is composed. According to Tammann, deformation take place by slipping along slip planes inside the grains. Accordingly, the plasticity of a substance depends on the slip planes formed by each crystal. These are crystallographically fixed planes according to Tammann, and according to F. Korber they are planes in which the crystal is characterized by a lower value of the shearing strength. Increased temperature facilitates the formation of slip planes in the crystal grains and thus the plasticity. Then the force that is applied for deforming a material will be smaller at a higher temperature than at a lower. We can regard the rolling pressure as the resistance to deformation offered by the material. According to Puppe, this resistance increases like a parabola from the fluid condition of the iron to its cold condition. This shows clearly the close relation between hot working of iron and the temperature. The investigations of Geuzes on the relation of the flow point to temperature can be used as a proof of this. These investigations are important in this case because a material must be loaded beyond its flow limit in order to get permanent deformation.

For this reason the greatest attention must be paid to the temperature differences in the material being rolled. These differences cannot actually be avoided; the surface of an ingot is ordinarily colder than its interior. Under certain circumstances this might cause unfavorable stresses in the material as the inside of the ingot is more plastic than the outside surface layer and therefore is more strongly deformed. The surface parts that are less yielding are drawn like rubber bands. Because of the internal cohesion the connection between the outer and inner layers is maintained, but each is under tensile stress. With unfavorable conditions on rolling, as when we have an ingot with a cooled surface and hot core, the stress in the outermost surface layers can be so great that the internal cohesion at these places is overcome, and the material breaks.

There are many references in literature on the significance of temperature differences in hot-working. K. Rummel states that the plasticity of a material being rolled is affected to a marked extent by temperature differences of 25 deg., and that differences of 100 deg. are not uncommon.

The temperature differences between surface and core are caused by radiation and conduction losses. The radiation losses increase, according to the Stefan-Boltzmann law, in direct proportion with the time, the area and the fourth power of the absolute temperature. The effect of the time can be increased easily above the permissible amount by allowing the material to stand too long, or by rolling too slowly.

If we investigate the method of operation in the blooming mill at the time of making the test, we see that each ingot is weighed just before rolling. In order that this will not cause a disturbance in serving the ingot train, each ingot is removed from the reheating furnace while the previous one is being rolled, is weighed and remains on the scales until the rolling of the previous one is finished. This ordinarily takes about 1 to 2 minutes. Also, at the time of making the experiments, the rolling time was rather long because, as stated before, rolling was done without using high initial temperatures with constant reductions in thickness of about 30 mm. This increased the number of passes. But, as according to Meerbach the pass time is only about 10 per cent of the rolling time, it is easy to see that this greatly increases the total rolling time. When the high initial temperature (and consequently great plasticity of the material) is not used, this is going against the old rolling rule, says W. Tafel which calls for the main shaping in the first pass because it is desirable to secure the shaping in as few passes as possible, since the fewer the number of passes, the shorter will be the rolling time and the less the cooling of the material.

The same holds true for the unnecessary increase in the heat loss by conduction as for the radiation.
losses. The conduction losses, which are in the same ratio to the area, time and temperature difference, also result in irregular cooling of the two broad sides of the sheet ingot. This temperature difference arises because the upper side of the material only comes in contact with the top roll, while the lower side comes in contact with the lower roll and the table rolls.

Rummel\(^\text{60}\) says that the heat losses by conduction are considerably greater than those by radiation. More attention must be given them on rolling sheets. The effect of the surface cooling, caused by these heat losses, on the formation of the defect is shown by the observation that, assuming ordinary heats, the defect is almost always on the side lying on the roll table.

We must also mention as disadvantageous the heat transmission from the hotter interior of the ingot to the cold surface, which is made harder because of the effect of the cold cooling water.

The effect of surface cooling on the cracking of the surface has also been observed by Pomp\(^\text{63}\) during pressing. At that time he stated that in many steels the temperature region of highest viscosity is closely restricted. The steels crack on the surface at places that are in contact with the cold saddles of the press when pressing for a rather long time, because at these places the material has cooled below the temperature for its best viscosity.

If surface cooling actually has an effect on the crack formation, then all places on the surface of the ingot that cool most must crack most strongly and frequently. This happens where most surfaces meet, that is, at the edges and ends of the faces. That this is actually so, is shown by a tabulation (Fig. 26) representing 3500 ingots, on the local distribution of cracks on the sheet blooms, according to which 90.4 per cent of the ingots were cracked at the edges and ends of the faces, while only 8.1 per cent showed cracks in the center of the faces. In general the cracking of the center of the face was observed most frequently in those ingots that had been heated too rapidly and therefore had a hot surface and a cold core. In this case the edge parts seem to be more extensible than the comparatively cold interior of the ingot so that here, counter to the above-mentioned cases, there are local cracks in the center of the face.

Other proofs showing the effect of surface cooling on the formation of cracks could be given. We shall take up the effect of spreading and creeping in relation to the temperature.

**Spreading**

The particles of material in the center move primarily in the direction of length, and only to a slight extent in the direction of width, while the particles at the edge of the piece are free to move out so that they undergo a comparatively great spreading in relation to elongation. The outside edge particles consequently must remain behind; however, they are carried along because of the internal cohesion of the large mass comprising the part that is only elongated. However, they offer resistance to this in the form of stresses. Accordingly, spreading results in an unfavorable stressing of the material. It disturbs the continuous flow of material in one plane, for it leaves this plane and moves in one perpendicular to it. In soft types of mild steel the spreading becomes greater as the temperature is lower and for this reason the colder edge parts of the ingot are subjected to the influence of spreading to a far greater extent than under equal temperature conditions. As is known, the spreading of the surface is greater than that of the core. Accordingly, there is justification in concluding that under unfavorable conditions, such as too great temperature differences between surface and core, the spreading can exert an influence on the crack formation of the surface.

**Creep**

The creeping also results in a stressing of the material and, if its irregular temperature is considered, it may influence the high stressing of the colder surface part under certain conditions. According to Puppe\(^\text{14}\) the creeping constantly becomes greater with decreasing temperature and reaches a maximum at 950 deg. The increase with decreasing temperature is greater as the reduction in height becomes greater. The colder surface in itself, and its coldest parts are more subject to creep than the hotter interior. According to Hollenberg\(^\text{65}\) the rolling process consists of a depression of the material and a drawing of the outside layers over the inside. The stresses to which the surface portions of the material are exposed are so great that the surface may crack readily under unfavorable conditions.

The actions of the individual influences mentioned, such as temperature differences between surface and core due to radiation heat losses, the heat losses due to conduction because of the removal of heat by the cold ingot scales, roll-table rollers and rolls, and also the cooling of the surface by the cold cooling-water, and finally the stressing of the surface portions by spreading and creeping, all combine and can cause local cracking of the surface.

In addition to these influences of temperature on the behavior of the material during hot-shaping there also should be mentioned the influence of the rate of deformation, as the deformability of a material, as stated before, depends on it. There remains to be considered the extent to which the rate of deformation can cause the formation of surface cracks on ingots with cooled surfaces. The rate of deformation according to Nadai\(^\text{66}\) and others has such a great influence on the plastic action of a metal, that plastic substances can be broken as if they were brittle, if they are loaded quickly enough. There is a so-called limiting deformation velocity that cannot be exceeded on forging or rolling without injuring the material. Since the limiting deformation velocity of the hot core is higher than that of the cooled surface, it is possible that under fixed (Continued on page 1472)
Use of the correct lubricant, and proper protection for bearings in stock will go far toward Preventing Anti-friction Bearing Troubles

By ELMER ZITZEWITZ
Chief Engineer
Aetna Ball Bearing Manufacturing Company

WHEN the Association of Iron and Steel Electrical Engineers convened in Cleveland last June, the subject of troubles with anti-friction bearings came up for discussion. Apparently electrical engineers have been having trouble on account of anti-friction bearings leaking oil which results in the destruction of electrical insulation, destruction of mica, poor commutation and similar troubles. None of these difficulties need necessarily be experienced and the only reason that they do occur from time to time is because one, two or more conditions are allowed to arise, none of which should be tolerated.

Anti-friction bearings are finding such wide uses that a few remarks about their operation and maintenance may be worth while and attention to the following will practically eliminate all the troubles about which so much was said at the convention.

Many anti-friction bearings are doomed to trouble and short life long before they are installed because they have not been properly protected against corrosion, grit and dirt while in stock. Stock clerks and operating engineers frequently fail to realize the importance of protecting anti-friction bearings against dirt, moisture and contamination from the atmosphere. Every anti-friction bearing shipped by the manufacturer or even before going into stock is carefully covered with grease or oil and hermetically sealed. In this way it will remain indefinitely untarnished and immune from corrosion, pitting, etc. Frequently, however, the bearings are allowed to be around in the plant with a broken wrapper or with a wrapper entirely removed; in other cases the grease has been allowed to dry up or become wiped out. In consequence, rapid corrosion takes place with pitting of the highly polished surfaces. Races, balls or rollers receive scratches and indentations. In other words, the bearing becomes defective even before it goes into service. Every bearing not in use and before installation should be carefully covered with a grease or oil which is inhibitive, non-hygroscopic and should then be wrapped so as to be protected against the atmosphere.

Lubricant

The bearing manufacturer is invariably glad to recommend the class of lubricant to use for the given service. While there is no well-defined speed above which oil should be used, or below which grease should be employed, because the lubricant serves the four functions of preventing rust and corrosion, minimizing friction, dissipating heat and forming a supplementary seal between rotating and stationary elements, it may be stated in general that oil is preferable for high speeds and grease for low speeds. Whether the dividing line happens to be 1500 r.p.m. or 2000 r.p.m., will depend upon the method of lubrication employed, the temperatures involved, absence or presence of dirt and similar operating conditions. However, "when in doubt, use oil" is a safe policy. Since the use of anti-friction bearings cuts the lubrication cost at least 80 per cent, it is a very shortsighted policy to attempt to purchase lubrication on the basis of cost per pound or cost per gallon. Yet this is frequently done. The first few charges of lubricant once the bearing has gone into service consist of the grease or oil recommended by the anti-friction bearing manufacturer. After that salesmen are called in and the cheapest oil or grease is used.

Animal and vegetable greases should never be used because they break down to form free acids or alkalis. Only a pure mineral grease or oil should be used, its consistency depending upon the speed, load and temperature. It is very important that the lubricant should be non-hygroscopic, so that it will
not absorb moisture, which causes corrosion. Nor should the lubricant contain any solidifying matter which may tend to clog the bearing and so cause unnecessary wear and friction. The lubricant should be absolutely free from such material as chalk, graphite and similar substances which tend to create a lapping action which, of course, leads to rapid deterioration. Where high speeds and elevated temperatures are to be contended with, it is important to employ a grease which will not break up and force out the oil from the bearings or form a gummy residue which may clog the rollers or balls and rupture the race.

During the discussion at Cleveland one instance was cited where a change of lubricant resulted in a temperature drop of 44 deg. F. Such experiences, surely, should emphasize the importance of correct and adequate lubrication. It is obvious that where high temperatures are encountered, trouble will be experienced owing to vaporization of the oil. Higher temperatures mean increased friction, increased thrust and greater wear and tear, so that everything contributing to lower operating temperatures is worth while.

In regard to loss of lubricant because of leakage and vaporization, the bearing manufacturer is able to seal his bearings against both of these. By means of cork, felt, leather and various forms of labyrinth, he is able to retain grease or oil during the life of the bearing. Unfortunately, oil seals are frequently omitted because the designer did not allow sufficient space for them; a bearing with oil seals requires from 30 to 50 per cent more space than a bearing without oil seals. Another reason is that an oil seal costs between 15 to 25 per cent, perhaps, of the cost of the bearing and consequently the designer in trying to keep down the cost of a machine refrains from adopting this refinement. It might be pointed out that for many classes of service an oil seal will pay for itself within one year because of the freedom from injury to the insulation and mica, and the good commutation. There is another point worth taking up, namely the use of the compromised bearing, which is a bearing designed to carry both thrust and radial loads. Such a bearing is necessarily a compromise. While it costs less at the start, it costs more in the long run. The overload capacity is less, the coefficient of friction is increased, the power consumption is greater and the required attention to lubrication will be increased.

Most of the troubles now being experienced with anti-friction bearings will be eliminated when every one responsible for the application, installation and operation of this type of bearing will bear in mind the five simple yet basically important requirements. These might be called the “big 5” and are:

1. Choose the proper size of bearing;
2. Choose the proper type of bearing;
3. Mount it properly;
4. Lubricate it properly;
5. Maintain it properly.

To these might be added: Keep all spare anti-friction bearings in sealed wrappings adequately protected against dirt, moisture and atmosphere after generously coating them with a rust preventive that is protective, inhibitive and non-hygroscopic.

When the “big 5” are adhered to, trouble owing to loss of lubricant will be eliminated and high temperatures will cease to be a problem. It might be well to point out in conclusion that since the use of anti-friction bearings will cut the cost of lubrication at least 80 per cent it is very shortsighted to attempt to cut the cost of lubrication by using an inferior and unsuitable lubricant.

Where the “big 5” are adhered to, anti-friction bearings will prove an even more profitable investment, being more dependable than ever and still greater savers of power and lubricants.

**Hair Cracks on the Surface of Sheets**

(Continued from page 1470)

conditions the given deformation velocity may lie below the limiting velocity of the core but above that of the surface. The surface must crack in this case.

**References**


(To be continued)

**Large Ingot Mold**

A large ingot mold has just been delivered from the Brightside Foundry & Engineering Company to the Vickers works of the English Steel Corporation Limited, at Sheffield.

The mold weighs 112 tons, and five traction engines were required to pull it, a crane of 150 tons capacity being used to load it.

In this mold ingots can be produced which are larger in size than any previously made in that country. These ingots will be used to make forgings weighing 98 tons and over.
Comments on the Pickling of Sheets

A man from the mill gives some information concerning this necessary process.

The importance of the proper pickling of steel preliminary to the several finishing processes now in use has of late proved of special value both in quality and cost of finished product. Especially is this true in the case of coated articles, such as galvanized sheets, etc.

It has always been the practice in the past to pickle sheets preliminary to galvanizing by rule of thumb. At the start of the week, new pickling solution would be made up by using so much acid diluted with water and operations would begin. When the operator felt that the acid was not quite hot enough, in would go the steam, usually getting it too hot. Towards the end of the week when fresh acid was needed, in would go whatever quantity the operator felt was the correct amount to bring it up to strength or if acid consumption was too great for the period owing to wasteful conditions, he would continue to use the almost spent solution and perhaps increase the temperature and time of contact. Under these conditions it is no wonder that results varied continually. More often than not "seconds" would be high the first part of the week, low during the middle and high again towards the end. The men in charge usually blamed the variations on quality of the steel and no matter how hard he tried, the open-hearth steel man could not satisfy the demands of the sheet steel man. In following special heats or parts of heats, owing to the conditions in the sheet mill, results were not always logical or correct because of the chance of getting mixed. The easiest and quickest way was to "pass the buck" and blame the steel quality.

The reason for pickling is to secure a clean metallic surface to which the subsequent coating will adhere uniformly and completely. Several items in the operation are of particular importance and once the conditions are established that will give best results, they should be rigidly controlled. The strength of acid, the temperature and time of contact, and the conditions of scale, all have a bearing on the finished quality. With all these variables entering into the operation, is it any wonder that proper control is necessary for uniform good results?

Investigation in each particular plant as to the above items is necessary to best determine or establish the working limits. We know that too strong acid or too long a time of contact wastes acid and causes the steel to absorb and hold hydrogen, which later shows up as "blisters" in the coated sheet. The analysis of the steel as to phosphorus and manganese has an important bearing on the kind of coating produced with zinc. The thicker the gage of steel the more chance for hydrogen absorption. If conditions are controlled, the operator has a better chance to overcome pickling troubles due to differences in scale that are encountered.

Testing Acid

The testing of acid is worthy of special attention and discussion. The first attempts at acidity control were with the hydrometer, which indicated the specific gravity of the pickling solution. Because of pressure of iron salts, it is impossible to tell how much of the hydrometer reading is due to acid and how much is due to the dissolved iron salts. Obviously then the use of the hydrometer is out of the question.

The acid control of the pickling bath can be readily determined by titration with standard alkaline solution such as caustic soda, but this method is not simple enough for the unskilled person and requires time and care. Then, too, the titration method has the disadvantage that dirty pickling baths should first be filtered and if rich in iron sulphate give trouble owing to crystallization. Further, the end point in samples rich in iron sulphate is interfered with because ferrous hydroxide is precipitated during titration.
A simple method for determining the acidity is to measure the amount of carbon dioxide given off when a known sample of acid is treated with an excess of a carbonate such as sodium or calcium carbonates. Such an apparatus is standard equipment in many inorganic laboratories and the manipulation is simple, quick and accurate. By this method, only, the actual free acid content is determined and by standardizing the apparatus so that a unit volume of liberated gas will correspond to a definite per cent of free acid, a quick result is secured. By testing at definite intervals, the operator knows exactly what he has in the pickling solution and can vary his temperature, time of contact, or add more acid as desired. This procedure will cut acid consumption and increase the quality of the finished coated sheet and by reducing "seconds" will cut costs accordingly.

**Faulty Pickling**

While it is true that the steel is not always perfect and occasionally a bad heat will produce poor results for the sheet man, it is likewise true that continually blaming the steel is not the answer for the troubles encountered in the producing of high quality galvanized sheets. If the sheet man will acknowledge that some of the defects are of his own making and first get his own "house" in order, then it is time to go to the steel producer with the definite knowledge that any changes in steel quality will be properly interpreted for better or worse.

**Author Comments on Cyanides**

The Editor,

Blast Furnace and Steel Plant.

Dear Sir:

I have read with special attention the criticism of Mr. S. P. Kinney on the article on "The Importance of Cyanides in Iron Smelting" in your August issue, the more especially as I consider the supplementary data given in Table I (Technical Paper 390) as the most important of all the data hitherto published on the presence of alkaline cyanides in the blast furnace, and this data we owe to Mr. S. P. Kinney and his colleagues.

The crux of the whole matter is, of course, the point at which the cyanides are formed. So far as I can trace, all who have previously studied the question have accepted the belief of Bunsen and Playfair that they were formed somewhere above tuyere level, and that excessive heat, or rather, a very high temperature, was necessary. My studies of the whole subject of the behavior of the alkalies in the furnace have led me to conclude that they are formed, if not entirely, chiefly, in the region below the tuyeres, just above slag level. And I submit that the quantities reported as found in various samples taken through the slag notch by Messrs. Kinney and Guernsey, and by Franchot,—prove conclusively that that is where they are mostly formed.

And that being so, it should be evident that we could not expect to find them in a sample drawn from immediately under, or immediately over a tuyere. Table I shows several such samples taken under a tuyere, and just as we should expect, show very little alkali present.

Further, it should be realized that the space available for gas between the level of the slag and that of the tuyere centers is not constant in volume, and so the extent to which gases truly generated in the well will be diluted or mixed with gas produced by the action of the blast on fuel, will vary with the level of the liquids in the furnace, and, doubtless, with the pressure in such space. The sample shown as containing cyanide equal to 558 oz. KCN per 1000 cu. ft. is the only sample therefor on record which can be taken as showing substantially the condition of things, since closing this tuyere above the sampling hole would be equivalent to shifting the sampling hole around the furnace a bit, away from the interference of the blast stream.

And it has to be noted that, as one tuyere,—that above the slag notch,—was closed, the furnace was not on full production, which, if temporary, affects things.

It is evident then that the samples referred to, although taken at the same point, were not taken under the same conditions, and I submit that a commonsense interpretation of the various data and conditions will justify the conclusion drawn, that only that sample which was found to carry cyanide equal

(Continued on page 1478)

<table>
<thead>
<tr>
<th>Total alkali, cyanide,</th>
<th>Alkali as cyanide, per cent</th>
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<td>Volume, cu. ft.</td>
<td>Ounces per 1,000 cu. ft.</td>
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<tr>
<td></td>
<td>calculated as KCN</td>
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<tr>
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<tr>
<td>1.34</td>
<td>152</td>
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<tr>
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<td>23.0</td>
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<tr>
<td>1.6</td>
<td>14.8</td>
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*Titration, 1 drop only; cyanide, less than .053 oz. per 1,000 cu. ft.
Surface Condenser Principles

Too often, perhaps, because of the apparent simplicity of condenser construction and operation, is its maintenance slighted, and, at the same time, no other single piece of equipment has more influence on the over-all economy of a power plant. Improperly maintained and operated, a condenser can offset all the other efficiencies of a plant, and will produce very uneconomical operation. Fig. 1 shows typical results of decreased vacuum on turbine economy. In view of the serious effects arising from this source, too much emphasis cannot be put on the importance of condenser design, selection, operation and maintenance. In discussing these points, we will consider only the surface condenser, as it is the general choice in modern power plants.

Heat transmission in surface condensers follows the general laws of heat transmission by conduction and convection. In this case, the resisting medium is the sum of the resistance from steam to tube wall, through the tube wall, and from wall to water, with additional complications arising from the presence of air in the steam to be condensed, and from the formation of water on the steam side of the tubes.

Reviewing briefly the theoretical formulae upon which condenser design is based, we have the following:

\[ S U D = W (H - q) \]  
\[ D = T_s - \frac{T_1 + T_2}{2} \]  
\[ U = \frac{Q}{D} \]  
\[ S U D = Q (T_z - T_i) \]  

where \( T_s \) = temperature of steam at given vacuum  
\( T_1 \) = inlet temperature of circulating water  
\( T_2 \) = outlet temperature of circulating water  
\( T_z \) = temperature of steam at given vacuum  
\( T_i \) = inlet temperature of circulating water  
\( T_o \) = outlet temperature of circulating water

Coefficient of heat transfer, \( U \), may vary from about 350 to 950 B.t.u. per sq. ft. per hr. per deg. F. and depends on the following conditions:

1—Material and size of tubes  
2—Cleanliness of tubes  
3—Air content of exhaust steam  
4—Water velocity through tubes  
5—Temperature of circulating water  
6—Water blanketing on steam side of tubes.

A formula in use for approximating the value of \( U \) is:

\[ U = 350 C_1 C_2 \left( \frac{P_a}{P_t} \right) \sqrt{V} \]

where \( C_1 \) = cleanliness coefficient (.5-1.0)
The selection of a condenser involves a study of the turbine characteristics, its proposed loading, cooling water conditions, and power and steam costs. These data are then resolved into a balance between the value of increased vacuum and the operating and fixed charges on the condenser. Extreme care should be used in determining cooling water conditions, and the proposed loading. Fig. 2 shows the sharp reduction to be expected in vacuum when a unit is overloaded, and this reduction is even more pronounced with warmer circulating water. Too often are these items improperly deter-

Condenser Design

Condenser design has been notably improved in the past few years, owing to the use of experimental data obtained from actual test on operating units. Experimental temperature, pressure and flow gradients have been established, which have resulted in a considerable rearranging of condenser surface so as to render it more accessible to the steam. Almost without exception, manufacturers have incorporated this data into their condenser design, and it has so supplemented the theoretical basis of design as to result in considerably higher efficiencies from the more modern installations.

The ratio \( P_s \div P_a \) in a tight condenser with efficient air pumps, will run .95-.97. Water velocity through the tubes usually runs 5 to 8 ft. per sec., and can be determined by dividing the volume of water flowing through the tubes per second by the combined cross-sectional area of the tubes in one pass.

The effect of the temperature of the circulating water on heat transfer can be minimized by keeping the water velocity toward the high side, producing turbulent flow within the tube. Water blanketing on the steam side of tubes is reduced by proper use of baffles or “dry-plates.”

Dezincification, or the removal of zinc, may arise from the presence of an acid, particularly in connection with high temperatures or dissolved oxygen. Spongy, brittle copper remains and tube failures result. Increased water speed will help to retard this action. Tubes low in zinc and iron are slow to react in this manner. About .02 per cent of
arsenic in the tube material is said to offer considerable protection.

Corrosion

General corrosion usually occurs on the inside of the tube, and results in a general, even thinning down of the tube. Oxygen in the water is the usual cause. Up to certain limits, high copper content in the tube material reduces corrosion.

Pitting and deposit attack results from contaminated water, and some form of protective coating is the remedy usually employed where the contamination cannot be avoided.

Corrosion caused by air bubbles is known as impingement, and may result in general thinning or in grooving, generally near the inlet end of the tube. Improving the smoothness of the water flow and avoiding the presence of free air by all possible means will retard the action.

Erosion owing to the presence of solids in the circulating water is also found.

Season cracking and splitting result from internal stresses set up in the tube during the process of forming. A thorough anneal will avoid this occurrence.

Fresh water conditions are usually less severe, but even there a tendency is noted to select tubes of a higher copper content.

In view of the importance of its effect on station efficiency, condenser maintenance cannot be stressed too heavily. Troubles commonly found are dirty tubes, water leakage and air leakage. Even a very thin deposit on condenser tubes will greatly reduce the rate of heat transfer, and consequently, the vacuum. If the water supply for circulating purposes is dirty or otherwise unfavorable, condensers are often made with a divided water box so that one-half of the tubes may be cleaned while the other half are operating.

Results of tests at the Williamsburgh plant, Brooklyn, using salt water are reported as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muntz metal</td>
<td>Bad</td>
</tr>
<tr>
<td>Admiralty metal</td>
<td>Fair</td>
</tr>
<tr>
<td>Aluminum bronze</td>
<td>Very good</td>
</tr>
<tr>
<td>Nickel silicon</td>
<td>Bad</td>
</tr>
<tr>
<td>Aluminum lined copper</td>
<td>Bad</td>
</tr>
<tr>
<td>Cu 80 per cent, Zn 19 per cent, Sn 1 per cent</td>
<td>Proving good</td>
</tr>
<tr>
<td>Cu 85 per cent, Zn 15 per cent, Sn 1 per cent</td>
<td>Proving very good</td>
</tr>
</tbody>
</table>

Deposits usually found on tube surfaces are silt, organic deposits, slime, or scale. Cleaning methods may vary with the type of deposit. Loose sediment can be removed by a jet of high-pressure water. Soft deposits can be removed by shooting rubber plugs through the tubes with hydraulic pressure. Metallic plugs, having a scraping action, are very effective, and will remove harder scale. Wire brushes or scrapers, are often used, and are very effective against hard or soft deposits. They should be followed by a jet of water directed through the tubes. Mechanical cleaners similar to those used for boiler tubes are also employed. These mechanical methods, however, require more time than plug cleaning. Sand blasting has been used for very hard scales, but this method is very disagreeable. A weak solution of hydrochloric acid may be used to dissolve and loosen hard calcium scale, but care must be taken to avoid corrosion. Fig. 3, taken from a report of the N.E.L.A. Prime Movers Committee, shows a comparison of the effectiveness of the various methods of cleaning.

The outside of tubes seldom require cleaning. Occasionally, however, boiler salts or oil may be present in the exhaust steam and will accumulate on the tube surface. Such deposits can be removed by filling the steam space with water, adding about 1½ lb. of sodium carbonate per 100 sq. ft. of tube surface, and introducing steam at the bottom of the condenser. About two or three hours of this procedure should suffice. Dirty tubes are indicated by low vacuum accompanied by low outlet temperature of the circulating water.

Each station can develop a record of the vacuum to be expected under various conditions of load and circulating water. When performance drops sufficiently under this record to justify the operation, the tubes should be cleaned.

Leakage

Where the circulating water is very hard or impure, its leakage into the steam space of the condenser may cause serious feed-water trouble. Although it is almost impossible to keep a surface condenser absolutely tight, this leakage can be kept so...
sight as to avoid trouble. Proper tube packing and attention to the tightness of the ferrules will eliminate serious leakage from this source. Tubes which fail are plugged at both ends until it is convenient to replace them. Leakage can be detected by testing the condensate, either chemically or electrolytically. The source of leakage is determined when the unit is not operating, by filling the steam space with water and inspecting the tube sheets and both ends of the tubes. If it is possible to hold about 30 or 35 lb. of air pressure above the water in the turbine casing, pressure difference on the two sides will approximate operating conditions, and small leaks are more easily found.

Air leakage is indicated by low vacuum, cold condensate, and a normal rise in circulating water temperature. Such leakage occurs largely around the low-pressure seal of the turbine and through the joints in the condenser, piping, and turbine casing. The amount of air leakage, at least for comparative purposes, can be determined by means of air meters supplied by the condenser manufacturers, or one can be easily made. Location of air leaks are usually detected by means of a candle flame. On the low-pressure turbine seal, however, this method is impossible, and it is customary to apply a little peppermint oil to the seal, and search for the characteristic odor at the air exhaust. Small leaks which remain after everything has been tightened may be stopped with a heavy asphaltum paint. If no air leakage is found even though the symptoms are present, the air pumps may be at fault. The trouble commonly experienced from this source is clogging of the nozzles by particles of rust, scale, etc., carried by the steam.

**Author Comments on Cyanides**

(Continued from page 1474)

to 558 oz. KCN per 1000 cu. ft. it can be depended on as approximately representing the concentration of alkali in the gas of the well, when in good working order.

I cannot accept the explanation offered as to the very high alkali content of this sample being due to projected accumulations. The fact that there were such accumulations proves that the furnace was colder at such points, and there is no reason whatever to suppose that the gas of the sample would not be chilled on traversing such colder space, and so lose some of its contained alkali (in adding to the accumulation), instead of picking up more, as it is suggested took place.

After a particular study of alkali transformations in the well, one has to believe that the evolution of alkali vapor (displaced by lime,—from the slag), will be reasonably uniform over the entire surface, and so presumably the formation of cyanides will also be reasonably uniform. There is no evidence that the cyanides do any reducing work in the well. so we may suppose that a sample of gas taken next the wall will agree in alkali content with one taken nearer the center of the furnace, in the sector in which the bulk of the gas generated below tuyere level must rise. This of course has to be taken as meaning in the gas (CO) simultaneously generated with the cyanides. Such gas is more or less mixed with gases from the combustion, and of course the concentration of alkali will vary with the extent to which the original alkali bearing gas has been diluted. (We can infer, however, from the figures of W. van Vloten that gas next the wall has less admixture of combustion gas than that found nearer the center, as we naturally expect.)

In calculating the amount of oxygen carried down into the well, it was taken that blast would be required for only 75 per cent of the carbon of the fuel. Richards in his “Metallurgical Calculation” (Prob. 57, requirement No. 6) finds that 93.8 per cent of the carbon of the fuel was burned to CO at the tuyeres—equal to 1734 lb. of the 1834.6 lb. charged. This would require a proportionally larger amount of oxygen, resulting in 288.4 lb. oxygen reaching the well instead of the 250 lb. used.

Again, the oxygen missing from the main blast stream would seem to warrant taking a larger fraction as being carried down in non-gaseous form below tuyere level, than the 5/9 part used.

This new unit of measurement enables us (if the composition of the gas carrying the cyanides is known) to calculate with reasonable accuracy, the rate at which such cyanides are formed, and it should be evident that in the figures submitted, care was taken at each stage not to overstate the amount.

Study of W. van Vloten’s figures of the gas composition at various points about tuyere level will satisfy anyone, that at the lower levels of the furnace, it cannot be assumed that samples obtained along one radial line will be similar to those obtained along any other radial line at the same level.

One point may be emphasized. Although, in the conditions of the Southern furnace from which the samples were obtained, cyanides are certainly formed at the rate of over 2 cwt.—taken as KCN. While each ton of iron is smelted, we must not suppose that there is of necessity any great amount present of accumulated alkali.

The cyanides leave the well as vapor, and at great velocity, but need not rise to any great height in the furnace before they are intercepted and destroyed in decomposing silicate of iron.

The intercepted alkaline bases return to the well as a thin liquid primary slag, and will run much ahead of the solid materials. It is this rapid circulation of the alkalies in the bottom parts of the furnace which enables them to do the vast amount of work which we must credit to their transformations.

Yours sincerely,

WM. M. CONNACHIE.

Coltness Iron Works,
Newmains, Scotland.
Free Vane Air Operated Recorder Controller

THE BRISTOL COMPANY, Waterbury, Conn., is offering a new line of Air Operated Recording Controllers, employing a "Free Vane" as the initiator of control, which is a new departure in Air Operated Control.

The "Free Vane" is attached to and actuated by a measuring element of a temperature or pressure recording system and moves between two air jets with stream lines coinciding placed opposite each other. In passing into these air streams, the "Free Vane" varies the amount of air which escapes from the jets, thus effecting control.

The arrangement and design of the two jets and the free vane are such that the vane floats between two equal air streams at right angles to its motion, hence the position and movement of the measuring elements are not affected. The recording device is, therefore, free to reproduce the temperature or pressure with complete accuracy.

Control from a frictionless device as described above permits the use of supersensitive measuring systems to which The Bristol Company has always been committed. With this sensitive measuring system are also coordinated the other well known Bristol's features of ruggedness and simplicity.

The component parts are easily accessible although compactly assembled. The point of control is easily set to a visible scale point by means of a key.

Referring to the sketch Fig. 1 the operation of the Free Vane Air Operated Recording Controller is as follows—

Air at 15 lb. pressure is admitted through connection (7) and carried through filter (8), one branch leading to an indicating gauge (9). The other branch turns to the left and supplies air to the control system. This supply branch in turn divides into two branches, one passes through an orifice (10) supplying the elastic element (11) and then through a connecting line to the opposing jets (5) and (6). The other branch supplies air to the pilot valve (12) and through the pilot valve to the

Fig. 1—Sketch of the operation of the recorder controller
indicating gauge (14) and outward to the top of the diaphragm motor valve (13).

The air which enters through orifice (10) is dissipated through jets (5) and (6). The amount which may be dissipated through these jets depends upon the position of the free vane (4). This vane, being directly attached to an elastic element (1) of the hollow helical type, is moved by changes in the temperature at the sensitive bulb shown in the bath at the lower right hand corner. The changing amount of dissipated air at jets (5) and (6) produces a pressure change on the elastic element (11) and a consequent deformation which operates pilot valve (12) admitting more or less air to the top for operating the diaphragm motor valve (13). The elastic element (1) also carries the recording pen-arm which is attached to the shaft (3).

The Free Vane Recorder Controller is enclosed in a two part cast-aluminum case of moisture-proof construction. It is furnished with inverted pen-arm and fountain pen as standard equipment. The chart is rotated by a powerful Spring Clock or Bristol’s Telechron Operated Clock. The case is available for wall or flush mounting. Furnished as a single or two-pen instrument in combination of pressure or temperature and has a pressure range up to 1500 lb. per sq. in. and temperature range up to 1000 deg. F., using 12-in. charts. Temperature measuring systems may be either vapor or gas filled depending on the operating temperatures encountered.

Patents covering this method of control are applied for and pending.

A new catalog No. 4001, fully illustrating and describing this instrument is ready for distribution.

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**Lubrotite—A New Principle in Gate Valve Construction**

The Lubrotite Gate Valve, because of its lubricant-seal principle of tight seating, is an ideal valve for general industrial uses. In this valve there is a unique duct system for introducing a lubricant-seal between the seating surfaces. The valve is sealed tight even though the seating surfaces have become damaged by scratches, deposits, or corrosion in the line. Other advantages of the valve are:

- Operates from 25 to 50 per cent easier than non-lubricated valves.
- Seating surfaces protected by film of lubricant.
- They will not become corroded, scratched, or injured as easily as non-lubricated valves.
- Frees set wedge—lubricant-seal separates wedge from seats slightly, freeing wedge that has become set from a long period of service.
- For a given service, outlasts ordinary valve many times. Reduces yearly valve expense to a minimum.

Recommended for boiler feeding water lines, boiler blow-off, water systems, chemical lines, paper mill service, and other services requiring an absolutely dependable valve.

The Lubrotite valves are made in both Pratt & Cady standard and extra heavy iron body patterns, and in Reading electric cast steel. The general dimensions are the same as the non-lubricated valves, so Lubrotite valves can be used for replacement service without changing the piping system in any way.

All valves seat absolutely tight without the use of lubricant-seal and can be used, if desired, as regular non-lubricated valves.

Lubricant-seals are supplied for various services—air, gas, water, chemical, petroleum products, etc. The lubricant-seals are packed in convenient pocket sealed boxes—24 cartridges to a box. Only a small amount of lubricant is needed for an application.

Full details concerning the Lubrotite valves can be obtained by writing to the Reading—Pratt & Cady Company, Inc., Bridgeport, Conn.

**STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., OF Blast Furnace & Steel Plant**

(Required by Act of Congress of August 24, 1912)

Name of Publication: Blast Furnace and Steel Plant, published monthly at Pittsburgh, Pa. (Report of October, 1931.)

Publisher—Steel Publications Inc., 108 Smithfield St., Pittsburgh, Pa.

Editor—Donald N. Watkins, 108 Smithfield St., Pittsburgh, Pa.


Names and addresses of Stockholders holding 1 per cent or more of total amount of stock:


Donald N. Watkins, 108 Smithfield St., Pittsburgh, Pa.

M. M. Zeder, 108 Smithfield St., Pittsburgh, Pa.

Known bondholders, mortgagees, and other security holders holding 1 per cent or more of total amount of bonds, mortgages, or other securities. None.

D. S. WATKINS, Business Manager.

Sworn to and subscribed before me this 30th day of September 1931.

ELEANOR K. GAUS, Notary Public.
Pyro Rapid Recorder and Radiation Tube

THE Pyrometer Instrument Company, 101 Lafayette Street, New York, N. Y., has just introduced an improved means for indicating and recording from 1000 deg. F. to the highest temperatures commensurate with industrial requirements.

The Pyro Radiation Tube eliminates furnace thermocouples, to which the source of trouble in pyrometer installations can be traced in many instances, especially at high temperatures, and in cases where gases, fumes and other influences affect their usefulness by causing deterioration, not only of the housing, but of the couple itself.

The thermocouples of the Pyro Radiation Tube is encased in a metal housing, chromium plated, and develops its energy by focusing on it the radiant heat light rays of the body to be measured. It has proven to be most economical and reliably accurate in plant operation, and can be used with almost any standard type indicator or recorder.

Its advantages over the use of rod thermocouples are claimed to be many; to mention a few:

1—The tube is not subjected to the immediate furnace heat, subsequently not influenced by dangerous gases, fumes, etc.
2—Radiation being absorbed by a minute thermocouple which reacts instantly, the usual time lag is reduced to a minimum so that temperature changes can be recorded more accurately.
3—It can be installed successfully to record temperatures in places unsuitable or impossible to reach with thermocouple wires.
4—It is not subject to the shortcomings of metal wires, which deteriorate when heated beyond rated capacity; in fact, the Pyro Radiation Tubes have no limit in measuring high temperatures.
5—Its life exceeds by far that of rare metal couples, and should the tube become damaged through accident, the thermocouple bulb can be replaced at a very nominal expense.

The ranges have been standardized and can be furnished as follows: 1000 to 2200 deg. F., 1100 to 2500 deg. F., 1300 to 2900 deg. F., 1500 to 3300 deg. F., 1600 to 3600 deg. F.

The Pyro Rapid Recorder is simple in design and rugged in construction, and is adapted for both plant and research work. The old method of arresting the galvanometer action for many seconds is eliminated. The new method of recording makes it possible to have a continuous and instantaneous recording of rapid changes of temperatures. Pyro Rapid Recorder imprints temperature change indications in less than a second in comparison with 20 to 60 seconds required by old methods. There is no depressor bar or any other mechanical action to prevent the free swinging of the galvanometer system. Attached to the moving system of the galvanometer is a rod carrying a capillary glass tube, one end bent to dip into the ink container, the other swinging freely close to the chart paper. An agitator, set in action by a 3 volt transformer, is located under the chart paper, and creates impulses which in turn, make contact between paper and the ink feeder.

The galvanometer, having jewelled pivots and being highly sensitive, is very responsive to the action of the radiation tube, and therefore permits instant recording of temperature changes.

Portland Cement Research at Mellon Institute

DR. EDWARD R. WEIDLEIN, director, Mellon Institute of Industrial Research, Pittsburgh, Pa., has announced the foundation of an industrial fellowship by the Green Bag Cement Company of Pittsburgh, subsidiary of the Davison Coke & Iron Company. The investigational work of this fellowship, which will be carried on by Raymond C. Briant, will be concerned with studies of the chemical and physical properties of portland cement and with the development of certain new cement products.

Mr. Briant has come to Mellon Institute from the United States Bureau of Standards, Washington, D. C., where, during the past several years, he has been engaged in research under the auspices of the Portland Cement Association. He was previously employed in the portland cement industry of eastern Pennsylvania, following the completion of his chemical engineering education at Lafayette College.
TRADE NOTES

Bailey Meter Company announces the location of sales engineers in two southern cities. M. J. McWhorter, who formerly made his headquarters at 39 Fairhaven Circle, Atlanta, Ga., is now located at 1708 Euclid Avenue, Charlotte, N. C. Mr. McWhorter continues as manager of the southern territory, and is assisted by J. H. Whittlesey, who has headquarters at 3201 Carlisle Road, Birmingham, Ala.

* * *

The Waterbury Farrel Foundry & Machine Company, machinery builders, of Waterbury, Conn., announce the formal opening of a sales office in Chicago, serving the Chicago district, northern Illinois and Wisconsin. The office is in charge of A. R. Nichols and is located in the Chicago Daily News Building, 400 West Madison Street. Mr. Nichols takes up his new duties as Chicago representative after several years sales and engineering experience during which time he was affiliated with the home office in Waterbury, Conn.

A contract for a 10,000,000 cu. ft. capacity, five lift, water-sealed gas holder has been awarded to McClintic-Marshall Corporation, Bethlehem, Pa., by the Philadelphia Gas Works Company. Fabrication is already under way and erection will be started in Philadelphia in November, on the basis of completing the work early in 1932.

Combustioneer Inc., Chicago, has produced at its Goshen, Ind., plant a new small automatic stoker with a noiseless ash remover at a nominal price. Ordinary installation requires less than two hours, and the stoker can be used in boilers or furnaces as small as 121/2 in. inside firebox diameter. It is designed to burn 1/4-in. screenings (low priced coals) either coking or noncoking, high or low volatile bituminous coal, as well as anthracite.

United Engineering & Foundry Company, which has demonstrated earning power over a period of 30 years, at the present time has in cash, marketable securities, including government bonds, and accounts receivable, all of which are considered good, an amount equal to a value of $16.50 per share on the common stock.

The Rust Engineering Company and the McCann Harris Corporation have been consolidated and are now offering furnaces under the combined Rust & McCann patents, to the sheet steel industry.

Rust Engineering Company, Pittsburgh, Pa., has received a contract from the Bethlehem Steel Company for the construction of two rotary hearth furnaces, to be installed at the Johnstown plant.

* * *

Three 300-hp. adjustable speed motors with control apparatus were recently ordered from the Westinghouse Electric & Mfg. Company by the Republic Steel Corporation, the order involving approximately $30,000. These motors will furnish the drive for rolling cold strip stock of stainless steel in the tandem strip mill of the Republic's Massillon works.

Westinghouse Electric & Mfg. Company has received an order for the largest synchronous condenser ever sold, according to Westinghouse engineers, who say that the machine will exceed by 50 per cent the capacity of any existing synchronous condenser. It has been purchased by the Commonwealth Edison Company of Chicago for use in the Crawford Avenue Station. When installed, the condenser with its auxiliaries will be 45 ft. long; 20 ft. wide and will weigh 400 tons. The condenser will have a rating of 75,000 kva. at 514 revolutions per minute, and the cost of the complete unit will be approximately $250,000. The auxiliaries consist of a direct-connected starting motor and high speed excitation equipment. The machine is to provide the voltage and power factor regulation necessary to obtain the maximum capacity of a 220 kv. transmission line.

W. C. Kernahan Eastern Manager for Steel Publications Inc.

W. C. KERNAHAN, who for some time was associate editor of Blast Furnace and Steel Plant, has been appointed Eastern Manager of Steel Publications Inc., with headquarters at 29 West Thirty-fourth Street, New York City.

Mr. Kernahan came to Steel Publications Inc. from the Jones & Laughlin Steel Corporation. While in the employ of this latter company, Mr. Kernahan spent several years as industrial engineer and as supervisor of lubrication for the Pittsburgh works. In the position of industrial engineer his work was of a general character and enabled him to obtain much experience in general steel mill practice.

Mr. Kernahan was graduated from Denison University in 1927.
PUBLICATIONS

Dust Recovery Inc., 15 Park Row, New York, N. Y., has issued a publication illustrating and describing the construction and operation of "Vorti­coso Dust Collector," which is manufactured by the company.

This bulletin also lists the many applications of this collector, giving illustrations of the various installations made in the different industries.

The Roots-Connersville-Wilbraham division of the International-Stacey Corporation, Connersville, Ind., has just issued four new bulletins covering its standard and heavy duty blowers and gas pumps.

These bulletins supersede all former bulletins on these products issued separately in the past by The P. H. and F. M. Roots Company, The Connersville Blower Company, Inc., both of Connersville, Ind., and the Wilbraham-Green Blower Company of Pottstown, Pa.

Return Bend Economizers is the subject of a new bulletin issued by The Babcock & Wilcox Company.

This publication describes a forged steel return bend type economizer in which all the latest features of design have been incorporated and which, the company states, provides a high rate of heat transfer with a remarkable freedom from expansion strains.

All the details of the economizer, such as the return bends, headers, tubes, casing, etc., are fully described and illustrated by photographs and drawings.

Typical installation views and setting plans are shown, demonstrating the adaptability of the economizer to various types of boilers. The booklet is attractively printed, bound and illustrated in colors.

Copies of this publication may be had by addressing The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

A 16-page booklet, Bulletin No. 1238, has been issued by The Dampney Company of America, Hyde Park, Boston, Mass. This publication features "Apexior" protective coatings for preventing corrosion of power plant equipment. Numerous illustrations supplement the descriptions and instructions which concern the product.

Chain Grate Stokers is the subject of a new bulletin issued by The Babcock & Wilcox Company.

This publication describes a line of chain grate stokers, which, the company states, are built with all the precision of fine machine tools.

The booklet contains full descriptions of the various types of stokers with suitable photographs and line drawings to illustrate each type. Typical setting views are shown, demonstrating the adaptability of the stokers to various types of boilers. The bulletin is attractively bound and illustrated in colors.

Copies of this publication may be had by addressing The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

The Southwark Foundry & Machine Company, division of Baldwin-Southwark Corporation, Philadelphia, Pa., has issued Bulletin No. 25, which consists of 31 pages of hydraulic tables and other data.

The company claims that this booklet is not just another handbook or data book. The needs of the engineer engaged in the design or use of mechanisms for producing loads by hydraulic means has been foremost in the minds of the compilers.

It is also claimed that some of the data has never appeared in print. For example: the tables and data of pages 16 to 19 inclusive, the data of page 24 and a portion of the data of page 21. The pipe table of page 11 is unusual and the data on accumulators, pumps, intensifiers and shock valves of pages 26 and 27 is almost unique. The inclusion of four pages of cross section paper for the user's own notes is a noteworthy convenience. The spring design graph of page 30 and weight of cylinders graph of page 31 are marked aids in design.

This bulletin is available on request from Baldwin-Southwark Corporation, Philadelphia, Pa., to those interested. State name, position, company with which affiliated, and address.

"Keeping Pace with Machine Design" titles a booklet just published by Cutler-Hammer, Inc., 213 N. Twelfth Street, Milwaukee, Wis., pioneer manufacturers of electric control apparatus. This publication details the construction, operation and application of C-H magnetic clutches, including a full description of the newly developed C-H duplex clutch. There are many installation photographs showing magnetic clutches applied to various types of machines. The schematic diagrams which demonstrate the action of the clutches are instructive and interesting. The booklet is written in non-technical language and goes beyond the scope of the ordinary type of descriptive literature in that it helps the designing engineer to solve those problems presented by present-day selling requirements in the machine field. A copy will be sent free upon request to the company.

Irving H. Jones, formerly associated with the Crucible Steel Company of America, New York, has been named western district manager of the Molybdenum Corporation of America, Pittsburgh. His headquarters will be at 208 La Salle Street, Chicago.

Leo H. Marks has been made president and general manager of the Federal Steel Corporation, Detroit.

A. C. McCarroll is now auditor for Jones & Laughlin Steel Corporation, Pittsburgh. He succeeds the late Joseph A. Doyle.
Inspired by the success of the 500-hp. fire tube boiler operated from waste gases from one of its open-hearth furnaces, installation of which was completed early in May, this year, Central Iron & Steel Company, Harrisburg, Pa., producers of steel plates and non-skid floor plates, is now completing the installation of two duplicate units. The boilers which furnish steam for operation of rolling mill engines are 22 ft. long and 9 ft. in diameter, each equipped with 470 tubes 2½ in. in diameter. Large fans exhaust the open-hearth gas through the boiler at high velocity while the steam is carried through the mill engines through a recently constructed 12-in. steam line 2,450 ft. long. Prior to the first installation the company had successfully employed nine fire-tube waste heat boilers of 150 hp., operated in conjunction with its heating furnaces.

The (British) Trades Union Congress recently on a card vote carried, by 1,794,000 votes to 1,434,- 000, a resolution urging that immediate steps should be taken to secure organized control of the British iron and steel industry and to provide the financial means for the industry’s rehabilitation and progressive development. The resolution was proposed by Arthur Pugh, on behalf of the Iron and Steel Trades’ Federation, and in proposing the resolution he expressed the opinion that the iron and steel industry could be restored to normal activity only by bringing it under public control and placing its organization, direction, and development in the hands of a public corporation.

Mead Penn Iron Works Company has been consolidated with the Pennsylvania Engineering Works, with William H. Lewis, president of the latter company, head of the new company which will be known as the Pennsylvania Engineering Corporation. Its headquarters will be at New Castle, Pa.

Pratt & Whitney Company, machine tool manufacturer, a wholly-owned subsidiary of Niles-Bement-Pond Company has bought the business and assets of the Keller Mechanical Engineering Corporation, Brooklyn, N. Y., manufacturer of die sinking machinery and electrical equipment for machine tool control. Operations will be transferred to Hartford, Conn., and consolidated with the plant of the Pratt & Whitney Company. Cash and stock in the purchasing company were the consideration in the sale.

According to notices appearing in the London Daily Mail and the Newcastle Daily Journal, the South African Railway Board has decided to place orders with British firms for approximately 9,500 gross tons of steel rails, the reported value of the order being £67,700. Three British steel companies share in this order—the Cargo Fleet Iron Company, Ltd., of Middlesbrough; the United Steel Companies Ltd., of Sheffield; and the Lancashire Steel Corporation, Ltd., of Warrington. No further details were reported published.

Plans for expansion of activities by the Midland Steel Products Company, Cleveland, were described by E. J. Kulas, president, at a dinner in honor of Harry T. Gilbert, newly named vice president and general manager of the company.

Appointment of Mr. Gilbert, who is widely known in the steel and automotive trades, is in line with the company's enlarged program which has made necessary an additon to the executive management, President Kulas stated. No other changes in the executive personnel are planned.

"Midland has augmented its engineering talent and speeded up its research laboratory work with the result that a number of promising new products in diversified lines have been developed," said Mr. Kulas. "For one of these products, a new axle housing, large orders have been received and $100,000 of new equipment is being installed for manufacture."

In addition to its automotive products which include frames and a complete line of four-wheel brakes for all types of passenger cars, trucks and busses, the company is planning to enter other fields, it was stated. The company's plants are located at Cleveland and Detroit.

Vice President Gilbert has been a steel company executive for many years, being associated with the Sharon Steel Hoop Company as vice president until 1928. In that year he became vice president in charge of sales of the Republic Iron & Steel Company and later, when the Republic Corporation was formed, he continued in the same capacity in the larger organization. In September 1930 Mr. Gilbert was made assistant to the president of the Republic Steel Corporation.
INGOTS LIKE THIS...

• A 19 x 22 x 85" ingot from a .14 carbon heat for seamless tubing (analysis of drillings upon request).

• Ingots like the one pictured are the regular day-in-and-day-out practice at plants using Gathmann big-end-up molds—an average bloom yield of 84% of sound steel.

• Blooms of any specification are sounder and freer of surface seams and blisters for having been produced from big-end-up ingots.

• With the new method of stripping big-end-up ingots now being introduced, sinkhead and non-sinkhead ingots can be produced and delivered to the mill at less cost per ton than has been possible heretofore.

• Investigate the possibilities of this improved Gathmann method in your practice. We shall be glad to answer your inquiries.

THE
GATHMANN
ENGINEERING COMPANY
"DESIGNERS OF INGOT MOLDS SINCE 1909"

Baltimore, Maryland
F. J. Griffiths has joined The Timken organization at Canton, Ohio. He has been elected director and president of The Timken Steel & Tube Company. M. T. Lothrop, president of The Timken Roller Bearing Company, has been made chairman of the board of The Timken Steel & Tube Company.

Mr. Griffiths comes to the Timken Company with vast experience and a broad understanding of the present problems of the steel industry, with which he has been prominently identified for 30 years. Until recently he was associated with the Republic Steel Corporation in the capacity of president of the Republic Research Corporation. Mr. Griffiths began his career in the steel industry with The United Steel Company at Canton, and later helped to organize The Central Steel Company in Massillon, Ohio, of which he was president and general manager. When these two companies were merged to form The Central Alloy Steel Company, he was chosen chairman of the board, which office he held until the Central Alloy merger with Republic.

W. W. Sebald, vice president in charge of distribution for The American Rolling Mill Company, has announced the appointment of R. C. Todd as assistant vice president of the company. Mr. Todd formerly was assistant general sales manager. His new duties will involve special work in connection with the company's sales activities. Mr. Sebald also announced that H. M. Richards, manager of Armco's Cleveland sales district, had been appointed assistant general manager of sales.

Howard H. Cook was elected secretary of the American Iron and Steel Institute, at a meeting of the board of directors, held on Friday, September 25. Mr. Cook has for some time been assistant secretary.

H. J. Freyn, president of Freyn Engineering Company, Chicago, sailed from England, October 7, returning from a three months' sojourn in Europe. Mr. Freyn has been in England, France, Germany and the U.S.S.R. where he has been inspecting the progress of contracts which this company is executing abroad.

Harry L. Erlicher, who entered the employ of the General Electric Company as an office boy in the purchasing department, has been appointed purchasing agent, succeeding L. G. Banker, who retired on October 1 after completing 43 years' continuous service with the company.

Walter Scott, assistant manager, metallurgical department, Republic Steel Corporation, Youngs-
A better billet heating furnace

because it has Bigelow Unit-Suspended Walls and Arches

Efficient operation, long life, low maintenance and freedom from repairs and shutdown are characteristics of this billet heating furnace in the Chicago District, because it has Bigelow Unit-Suspended Arches and Unit-Suspended Walls.

The unusual adaptability of Bigelow Arches and Walls makes it unnecessary to compromise the most efficient furnace design because of structural limitations. This adaptability is well illustrated by the adjustable hooks that permit changes to be made in the slope of the Bigelow Arch, should actual operation prove that a different roof contour is better adapted to the particular heating requirements. Such changes in arch contour are quickly made from outside the furnace and necessitate no alterations in the supporting steel.

The life of Bigelow Walls is always several times that of solid walls because each tile in the Bigelow Wall is individually supported—there is no cumulative loading of the refractory. Each 2- or 3-tile unit of the Bigelow Arch is also supported independent of every other unit—even when the arch has a steep slope the lower blocks do not carry any of the weight of the refractory above them. Each refractory unit of the Bigelow Wall and Arch is also free to expand and contract without imposing stress on itself or adjacent refractory units. The principal causes of spalling are thus eliminated.

This furnace was placed in service during August, 1929. It has required no repairs and apparently is in as good condition as it was at time of installation. Information regarding the application of Bigelow-Liptak Walls and Arches to your furnace requirements will gladly be sent on request.

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BIGELOW-LIPTAK
A SUSPENDED WALL AND ARCH FOR EVERY FURNACE
town, Ohio, has been made superintendent of the Bessemer plant. Joseph P. Welsh has been named superintendent of the blooming and bar mills, same division. Edward Mandy has been transferred from Massillon, Ohio, to Youngstown, as safety supervisor, taking the place of E. R. Rose, now director of employment, Youngstown district. Changes were effective October 1.

W. C. Buchanan, vice president of the Keystone Steel & Wire Company, Peoria, Ill., has been made a director of the company.

Ralph X. Robertson, until recently chief mechanical engineer for the Blaw-Knox Company, has become affiliated with the Atwood Bradshaw Company, Pittsburgh, Pa.

Myron H. Clark has been elected vice president in charge of operations of the Reading (Pa.) Iron Company.

F. E. Fleming has become sales engineer at the Chicago office of the Riley Stoker Corporation, Worcester, Mass., and R. L. Sauer has been made Detroit district manager. M. L. Cornelious has been appointed district manager at Cleveland, I. W. Lachman, sales engineer at the New York office, and W. J. Ehmer, sales engineer at the Philadelphia office.

George E. Totten, who has been assistant to the manager of tin plate sales for the Jones & Laughlin Steel Corporation, Pittsburgh, has resigned and has been appointed manager of sales, tin plate division, for the Republic Steel Corporation, Youngstown. He assumes his new duties on October 14. Mr. Totten is a native of Pittsburgh and entered the employ of the Jones & Laughlin Company 21 years ago. He has been identified with the tin plate department since the company entered this line of business and had held his recent position for 15 years.

Harrison Hoblitzele, formerly executive vice president of General Steel Castings Corporation, Eddystone, Pa., was elected president of that corporation at the September meeting of their board of directors.

**Robert D. Platt Dead**

ROBERT D. PLATT, chief engineer of the Koppers Construction Company, died suddenly at his home in Pittsburgh, Pa., on September 25, aged 46 years. Prior to joining the Koppers organization in 1912, Mr. Platt had worked with the Pencoyd Iron Works in Philadelphia, the Cambria Steel Company at Johnstown, and the Illinois Steel Company at Gary, in various engineering capacities. As chief engineer of the Koppers Construction Company, Mr. Platt was prominently identified with the by-product coke and gas industry. He was a member of the Eastern States Blast Furnace and Coke Oven Operators Association.
Uniformly Rich Gas at Low Cost

The uniform distribution of fuel in small quantities by the gas-tight coal feeder; the constant mechanical agitation of the entire fuel bed resulting in rapid gasification and the continuous ash removal which maintains the fuel bed at a constant level, are the operation features of the “WOOD” fully Automatic Gas Producers which ensure a steady flow of uniformly rich gas at low cost. As operation is automatic, labor charges are reduced to the minimum. The large gas output decreases the number of producers required. The cost of maintenance is almost negligible.

Write for full information. We will arrange for you to inspect an installation in regular operation, where these advantages will be demonstrated.

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PHILADELPHIA
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Air-Operated Gates—Atlas Indicating and Recording Mechanism — Operator’s Station and runway permit easy access to bin gates.

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- Pushers, Charging Cars, Door Handling Machines and Coke Quenching Cars for By-Product Coke Ovens.
- Atlas Patented Indicating and Recording Mechanism.

THE ATLAS CAR & MANUFACTURING CO.

Engineers Cleveland, Ohio Manufacturers
Sheet and Tinplate Rolls*

By J. Selwyn Caswell

(Continued from October issue)

15—Eighty-two per cent of the roll breakages take place through the body of the roll, and only 14 per cent take place from the neck to the body of the roll, while the remaining 4 per cent are fractures by spalling or torsion fractures of the necks or wobblers. A summary showing the location of the fractures is shown in Fig. 1.

The Loads Carried by Sheet and Tinplate Rolls

Common to top and bottom rolls:
1—The load set up by the deformation of the piece as it passes between the rolls.
2—The impact loads which occur simultaneously with the sudden entry and exit of the piece to and from the rolls.

On the bottom roll only:
3—The torsional load, which in the case of a leading mill is equal to that required to operate the whole train of mills.
4—The longitudinal forces which are set up on the wobblers of the rolls by the spindles and wobbler boxes.

N. B.—There is a torque on the top roll, viz., the frictional torque, but its magnitude is, of course, negligible compared with that on the bottom roll.

The most important of these are Nos. 1 and 3, and they account for nearly the whole of the load which is applied to a roll.

The Longitudinal Forces Set Up on the Wobblers

These forces are set up as a result of the absence of true alignment in the mill train, and their magnitude is considerably altered, if the wobblers are eccentric and inaccurately formed.

It is a common practice in sheet and tinplate mills to set the mills at different levels. The loading mill is placed 1/4 in. to 3/4 in. above the flywheel shaft, and each trailing mill is placed about 1/4 in. below the mill on its leading side. This is regarded as a necessary arrangement in the millwrighting of these mills, to insure rigidity of the mill and consequently better “stretch” of the iron.

When two turning elements which are fixed at different levels are rigidly connected by a spindle, turning of the elements would not take place unless the applied torque was large enough to produce cyclical deflections of the connecting spindle. Un retarded rotation, except that prevented by friction, could be obtained only with properly designed connecting elements, e.g., a double Hooke’s joint, or an Oldham coupling, both of which are impracticable for the requirements in sheet and tinplate mills.

The box and wobbler coupling, although crude in form, is a simple and convenient method of connecting two rolls which are not in line, and the looseness of the fit of the boxes allows turning to take place in a suitably free manner, deflection of the spindle now being avoided by the sliding which takes place between the boxes and the wobblers. If this sliding cannot take place, then slight elastic distortion of the turning elements must occur. Under the most favorable conditions, sliding can take place only when the frictional resistance between the sliding surfaces is overcome.

These forces, which oppose sliding, act in opposite directions, and probably give rise to a resultant couple and thrust on the wobbler.

It is difficult perhaps to believe that the forces can have a magnitude of great importance, but the following incidents, to describe only a few, indicate in a striking way how large they may become:

1—Complete disturbance of the mill and its foundation.
2—Thinning of a “piece” to a thickness of 1/32 in., although screw pins were set to give an after pass thickness of 1/8 in.
3—The pulling into line of a train of tinplate mills, when the wedges holding the housings in position had been removed.

—The stalling of an engine driving a train of five sheet mill cold rolls. Correction of the alignment conditions completely eliminated stalling.

(To be continued)
Industry Advised to Study “Safety” During Slack Period

An outstanding subject to be brought before the fifteenth annual New York State Industrial Safety Congress, in Buffalo, November 16, 17 and 18, is that of “Safety Preparedness,” by which is implied the utilization of the present period of slackened business for the improvement of conditions affecting safety and the introduction of safety measures in industrial plants.

Because many industrial and construction companies are being operated with reduced working forces and reduced working hours, it is believed that safety measures may be introduced more easily now than during periods of intense activity. Organizations may make surveys of their plants, removing hazards, installing safety devices, and training the personnel in methods of safety, and improving in general all conditions affecting safety.

The full benefits of safety plans and practices now introduced will be realized when economic conditions become more settled and industrial production and construction work are on the up-grade, with accompanying increase in the number of workers.

All sessions of this year’s Safety Congress and the safety exhibits will be held in the Statler Hotel in Buffalo.

Industrial Commissioner Frances Perkins is president of the Safety Congress, Deputy Commissioner Elmer Andrews is vice president, and George P. Keogh, Industrial Code Referee of the New York State Department of Labor, is secretary.

Farrell Works Makes Record

The Farrell Works of the American Steel & Wire Company report that an average of 490 employees have achieved a record of 691,220 man-hours without a lost-time accident. This report was made as of December 31, 1930, at which time no accident had occurred since April 18 of the same year. The electrical department, with an average of 13 employees including electricians, crane operators, and tractor operators, had no lost-time accidents since December 19, 1912. The nail mill, with an average of 90 employees, worked 2,702,340 man-hours from April 18, 1924, without a lost-time accident.

Carpenter Steel Company Reduces Accidents

The accident experience of the Carpenter Steel Company, of Reading, for 1930 showed a decrease of 66 per cent in frequency and a decrease of 88 per cent in severity as compared with the same period in 1929. Anticipating the drive against accident peaks in 1931, this plant, with an average of 1,100 employees, showed a 75 per cent reduction of March accidents in 1930, and a no-accident month in October. In January, 1931, the electrical department with an average of 40 men entered its eighth year without a lost-time accident. The year 1930 completed 15 years’ operation of organized safety by the Carpenter Steel Company.

Safety Trophies

Steel companies again were high in the lead among industrial groups rewarded for safety work at the twentieth annual national safety congress and exposition, Chicago, October 12-16. Trophies and certificates were presented to: R. A. Beyer, Central Tube Company, Ambridge, Pa.; J. A. Coltrain, National Radiator Corporation, Johnstown, Pa.; J. C. Bilek, Driver-Harris Company, Harrison, N. J.; Dr. R. C. Engel, Corrigan, McKinney Steel Company, Cleveland; W. A. Gimbel, General Electric Company, Philadelphia works; John M. Turnbull, Kensington Steel Company, Chicago.
Refractories Manufacturers Meet

Problems relating to the manufacture and application of refractories were discussed at the fall meeting of the American Refractories Institute held in Cleveland, October 9. Some 35 members attended the sessions.

Two papers on dry pressed brick were presented as follows: “Improving Dry Press Brick by the Removal of Air,” by Dr. George A. Bole, research professor, engineering experiment station, Ohio State University, Columbus, Ohio, and “Effect of Various Factors on Pressure Transmissions in Dry Pressing,” by Prof. C. M. Dodd, Rolla School of Mines, Rolla, Mo., and secretary of the committee on dry press process.

Other papers were: “Notes on Firing Refractories,” by S. M. Kier, vice president, General Refractories Company, Pittsburgh; and “Permeability of Refractories to Gas at High Temperatures,” by Stuart M. Phelps, director, refractories fellowship, Mellon Institute of Industrial Research, Pittsburgh.

Open discussions were held on the subject of firing of refractories, causes of kiln marking and secondary expansion.

Refractories Will Receive Attention of Ceramists

The program for the annual fall meeting of the Ohio Ceramic Industries Association, which is scheduled to be held at Lord Hall, Ohio State University, November 6 and 7, has been completed by Secretary H. E. Nold and promises a wide variety of topic and results of investigations in practically every line of the industry.

In the refractories division, C. H. Taylor, president, and H. T. Burr, both of the Charles H. Taylor Sons Company, Cincinnati, will report on the accuracy of pyrometer readings on ceramic kilns.

The erosion effects of boiler furnace slag in refractories will be discussed by E. P. Rexford of the U. S. Bureau of Standards, with illustrations by lantern slides. Another feature of this section will be a round table discussion of wear resisting metals as used in the ceramic industry, by C. E. Bales, vice president of the Ironton (Ohio) Fire Brick Co.

The report of the committee on specifications for kiln refractories will also be a feature of this section.

A Book—Refractories


Both the manufacturer and the consumer of refractories will find much valuable information in this book. Mr. Norton, assistant professor of ceramics at the Massachusetts Institute of Technology, has, in obtaining material, supplemented his own wide experience with that of many manufacturers, especially the Babcock & Wilcox Company. The fundamental processes in the manufacture and use of refractories are treated at length. From this book the reader can obtain comprehensive information of the processes involved in making refractories and the service they will give. Starting with a description of the mining of refractory materials, Mr. Norton describes the various processes followed in shaping and burning the several varieties of refractories.

A valuable feature of this book is the attention given to the application of modern equipment, instruments, etc.

The author has well succeeded in accomplishing his purpose: “to fulfill the demand for a modern treatise on refractories.” One chapter is devoted to refractory cement and plastics.

Natural Gas for Brick Kilns*

Of the various gaseous fuels, natural gas is the most desirable. It has a high heating value, which generally averages 1,000 B.t.u. per cu. ft., which makes it possible to transport it through pipes of small diameter—an important saving. It is a clean fuel, very easy to control and usually free of impurities. There is no dirt or sediment to accumulate and it is always possible to keep the kiln and ware perfectly clean. There is a very decided saving in labor over other fuels, and with an efficient draft control system one man can watch the firing of many kilns. In yards having 15 to 25 kilns one man can look after this work. This places the fuel control in more intelligent hands than with other fuels.

For many years a number of plants have used natural gas, but

*Paper delivered before The American Ceramic Society.
"Improved" Lavino Chrome Brick in the Basic Open Hearth

Several years ago a prominent Western Steel Company used an average of 5,000 Chrome Brick in the construction of each of their 100 ton basic open hearth furnaces.

Today, this same company is using between 35,000 and 40,000 "IMPROVED" Lavino Chrome Brick in each complete rebuild and refractory costs per ton of steel have been reduced.

We recommend "IMPROVED" Lavino Chrome Brick in the bottom, end slopes, monkey walls, front walls and back walls, which conforms with the generally accepted standard of good construction throughout the industry.

Depending on furnace design and operating conditions, "IMPROVED" Lavino Chrome Brick can be economically used in ports, up-takes, and end panels.

A—Face all surfaces of gas up-takes with nine inch header course of "IMPROVED" Lavino Chrome Brick. Up-takes protected in this manner last the full run of furnace.

B—"IMPROVED" Lavino Chrome Brick end panels eliminate repairs during entire furnace campaign.

C—"IMPROVED" Lavino Chrome Brick on port side of bridge wall protected with prepared Lavino Chrome Ore resists abrasive action of gases.

D—Slope of bridge wall is fully protected by several courses of "IMPROVED" Lavino Chrome Brick capped with prepared Lavino Chrome Ore.

E—End slope of "IMPROVED" Lavino Chrome Brick eliminates danger of wild heats cutting through.

F—Water cooled port lined with "IMPROVED" Lavino Chrome Brick will maintain original port lines throughout a long campaign.

G—Increase service life by protecting top and sides of water cooled port with "IMPROVED" Lavino Chrome Brick and cap with prepared Lavino Chrome Ore.

H—LOFERO (Periclase) Brick capped with prepared Lavino Chrome Ore give the best protection at port nose.

I—Build port facing with LOFERO (Periclase) Brick and bank with prepared Lavino Chrome Ore.

J—"IMPROVED" Lavino Chrome Brick monkey walls resist molten silica wash from roof and maintain the original contour of the throat of the furnace.

The saving in first cost is between $65.00 and $70.00 per thousand, in favor of Chrome Brick. A better product for less money.

Consult one of our refractories engineers on all new applications of IMPROVED Lavino Chrome Brick. Our men are trained to recommend only applications which can be supported by laboratory or performance records.
they have been so situated that they were near the source of gas supply. These plants have always been known for the high quality of product manufactured. However, very recently long pipe lines have been laid from the gas fields to various manufacturing centers so that many plants will now be able to take advantage of the economies that can be effected by using this type of fuel.

It has been our experience that one of the most important things in the use of natural gas is to have a well constructed kiln in which to burn it. It is absolutely necessary for best results to have a kiln which is built with all walls properly tied in, thereby minimizing the chance for air infiltration. The open and spoke type of kiln bottom seem to give equally good results. Some operators prefer the spoke type on account of lower maintenance cost.

**Furnace Walls***

*By George P. Reintjes  
President of the George P. Reintjes Company*

*Part II*

The majority of the first class brick masons throughout the United States are affiliated with an international union. This union is one of the strongest in existence. From our experience in using members of the bricklayers union, as well as craftsmen of other unions, we will say that the bricklayers union is the hardest headed and still the fairest of all with which to deal.

You have undoubtedly been impressed with the thought that the union controls the production of the brickmason. This, in a way, is a fallacy. Officially, the union has never controlled the amount of brick a mason should lay. However, local conditions creep in where the production per mason is materially reduced. In the average city where furnaces are installed, every mason is personally acquainted with every other mason in the city, and no mason desires to take advantage of his friend by showing up his inefficiency.

There is a strict rule in the union that prohibits a mason from laying a brick above the course where the line is stretched. To build a furnace wall it is the custom to build a "lead" at the corner which serves as a guide and as a support for the line to which the brick are laid. To build these corner "leads," requires a mason at each corner to build the angle structure, that is, the corner "lead" that serves as a guide for both walls. It is also the duty of the mason at each corner to raise the line from course to course for the masons working intermediate. Should the mason at the corner raise the line for another course before the last man is "out of the hole" or in other words, before the last brick has been laid on the preceding course, he is subject to a heavy fine by the union. This is true not only of furnace walls, but also building walls. The next time you watch masons working on a building wall, you will notice the men shifting so as to assist a fellow mason who is a little slow in completing his section, the balance of the masons waiting until the line is again raised. This simply means that the amount of brick laid per man is governed by the speed of the slowest mason on the wall. The production is also affected by the man at the corner working on his "lead" instead of watching and snapping the line as soon as the last brick is laid and the brick for the next course is available.

We have overcome this situation by a very simple method that has not only increased the production per mason, but also has improved the strength of the furnace structure. By placing two tile at the angle as shown in the accompanying illustration (Fig. 1) it is unnecessary to maintain a mason at each corner working on the "lead." He spends his time assisting other masons in laying brick to the line. In this way, we save the time of from one to two brickmasons, in addition to allowing the corner man to watch the progress of the work more closely.

This simply means that we have reduced the cost of the labor on the average furnace lining, by approximately 25 per cent.

As mentioned before, very little improvement has been accepted by average furnace engineers in the design of the furnace wall. However, they have made some changes, many of which are of doubtful value. For instance, some engineers desire to build expansion joints in the corner of the furnace, severing the walls that are subject to excessive vibration, into four slabs; whereas the earliest of the ancients have used the angle at the corner of their building walls to increase stability.

*This is the concluding part of the third of a series of articles by Mr. Reintjes on the subject of furnaces and refractories. The first appeared in the June, 1931, issue.*
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They raise the available line pressure of 800 pounds to 3000 pounds per square inch in steps of 250 pounds each. The intensifier rams are so located that the load on the cross head carrying the high pressure ram is always absolutely balanced. The manifold, with its built-in stop valves, provides for convenient operation in regulating the intensifier to the required pressure.

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No effort or expense has been spared to produce this new Morse roller chain. Old principles of roller chain joint construction have been eliminated. More than 32 years of chain manufacturing experience is behind it.

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MONO-LINE

MONO-LINE is a highly stable plastic refractory for building complete jointless furnace linings; for molding one-piece furnace doors, molds, etc.; for pouring in hand or machine for refractory fill and backing in water walls; for general repair work. MONO-LINE forms a solid, monolithic structure that is air- and gas-tight, and practically neutral as to expansion and contraction.

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Blast Furnace and Steel Plant

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STEEL PUBLICATIONS INCORPORATED

Publishers of

Blast Furnace and Steel Plant
(An A.B.C.-A.B.P. Paper)
The engineering authority of the steel industry. Published monthly by an organization of former steel mill officials.

Welding
The magazine that dominates the welding industry, the eighth largest industry in the U.S.A. Over 92% of its readers are men upon whom rests the responsibility of recommending and buying the equipment advertised in its pages.

Heat Treating and Forging
(An A.B.C.-A.B.P. Paper)
The only A.B.C. monthly journal in this field. Contains a special thirty-two page section devoted exclusively to furnaces.

Directory of Iron and Steel Plants
Contains a list of companies and officials operating Blast Furnaces, Steel Plants, Rolling Mills, By-Product Coking Plants, Structural Steel Plants, Boiler and Tank Shops in the United States and Canada. Published annually.

Directory of Forging, Stamping, Heat Treating Plants
Contains a list of Forging, Stamping and Heat Treating Plants together with Railroad Shops, giving a complete list of officials, equipment, and products manufactured. Published bi-annually.

108 Smithfield Street Pittsburgh, Pa.
Simplify your roll neck mounting by using Timken Bearings

With Timken Bearings on roll necks, no auxiliary supports, such as thrust bearings or thrust collars are needed. The Timken Bearing is geometrically designed to carry all thrust loads and all radial loads within itself.

The Timken Tapered Roller Bearing is the only type of bearing that can be set up with extremely close radial running clearances, and maintained in that condition during its entire life. That means any clearance, from zero to the exact amount required for the accurate rolling of any product—bars, rounds, sheets, strips, etc. The geometry of the bearing, as shown in the illustration, makes this fact obvious.

The wear that occurs in a Timken Bearing during operation, does not necessitate take-up any more frequently than a "non take-up" bearing has to be replaced. Thus the life of the Timken Bearing is much longer. This extended life represents years of added service...many extra tons rolled...uninterrupted operation...and thousands more dollars in profits. Timkens can be applied to your present mill equipment. Write for complete information.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO
This Lewis Vertical Edging Mill, now installed in one of the large steel plants operating on a 24” continuous bar mill, is designed for continuous strip and sheet bar mills. It can be installed on existing or new mills to edge any thickness and width slab desired. Can be furnished driven from existing drive shaft or independent drive. This mill is designed to work on any part of the roll face.

ABOVE: View showing roll adjusting arrangement which can be driven with motor or by hand, as desired

BELOW: View showing rolls and arrangement for delivering bars to following stand when edging is not necessary.

LEWIS FOUNDRY & MACHINE CO. P. O. BOX 1591 PITTSBURGH, PA.
A STATEMENT of particular interest to ELECTRICAL ENGINEERS

KEYSTONE GREASE No. 6 Light (liquid) is the most efficient lubricant for electric motor bearings of ring, chain, or collar type.

It has the required fluidity to be carried by the ring from the base reservoir to the shaft, but it does not thin out in operating temperatures to cause creepage onto the armature field.

Electrical engineers agree that the major cause of deterioration of armature windings is oil contamination. No. 6 Light eliminates the cause, and thereby lengthens the service life of the armature.

While the first cost of No. 6 Light is higher than engine oils used in some plants for motor lubrication, the heat-resisting quality of No. 6 Light which prevents creepage, also minimizes quantity consumed; this results in a decreased lubrication cost.

No. 6 Light has a low-cold test and works efficiently in cold weather in exposed places.

Altogether, this liquid grease offers a combination of advantages that highly commend it for the purpose specified.


KEYSTONE Lubricants

© K. L. Co. 1931
BETTER INGOTS

Improved Quality Thru Modern Mold Design

The design of an ingot mold is of as great importance as any item that has to do with the producing of good steel of any specification.

- Steel plant practice has made tremendous strides in cutting down costs and improving the quality of its output—Gathmann Mold Designs have kept pace.
- More than ever before the design of your molds warrants consideration, for every step towards better design in the mold assures a better ingot.
- You may have trouble with molds cracking, ingots sticking, poor yields, and worst of all, a mediocre product when you want good steel.
- Present-day Gathmann methods overcome these troubles. Gathmann mold designs represent some twenty years of research in steel production.
- Our representatives will be glad to call or we will design a mold for your specific practice, without any obligation.

THE

GATHMANN ENGINEERING COMPANY

Baltimore
Maryland

"Designers of Ingot Molds Since 1909"

"No steel product is sounder than the ingot from which it is produced"
ROLLING MILL EQUIPMENT
FOR
HOT OR COLD ROLLING

BLISS CLUSTER MILLS
ROLLER-BEARING EQUIPPED

These mills are built in capacities ranging from 4" to 72" wide for hot or cold rolling. Full details on request.

E. W. BLISS CO., BROOKLYN, N. Y., U. S. A.

BLISS for MACHINERY

No. 580
The G-E THRUSTOR—

an electric device that produces straight-line motion with a smooth, powerful thrust

1. Reduces Effort
2. Simplifies Operation
3. Increases Production

Here are three applications where the new G-E thrustor is [1] reducing physical effort, [2] simplifying operation, [3] increasing production:

1. Here, where a thrustor has been installed in place of a pedal, all operations are now directed by push-button control. Physical effort has been reduced.

2. These batch gates originally were operated manually. Now the G-E thrustor permits them to be operated automatically from conveniently located push buttons — greatly simplifying operation.

3. Formerly the operator of this embossing press stood beside the machine and threw a mechanical clutch in and out. The thrustor now enables him to load the machine, push a button, and then go to another machine while the first is performing automatically. Production in this case has been substantially increased.

You should have complete information on the G-E thrustor — and Bulletin GEA-1262A will give you just that. Ask your nearest G-E office for a copy.
There is a Correct Type of **UNITED**

**UNITED ROLLS**
- Unefco Hard
- Unefco Medium
- Unefco Mild
- Hot Mill Chilled
- Regular Chilled
- United Spec. Steel
- Regular Steel
- Lincoln Spec. Iron
- Sand Iron
- Adamite

*LARGEST ROLL MAKERS IN THE WORLD*
Trade requirements for rolled products are more exacting today than ever before. Every section rolled, whether standard or special, must meet rigid specifications and inspection tests, covering quality, finish and accuracy. Therefore, it is of utmost importance that the best rolls be used to obtain maximum tonnage of saleable material.

United rolls have been developed in conjunction with the rolling mill industry to meet the most exacting requirements. In this development, close contact has been kept at all times with operating conditions and the growing needs of the trade. They are now made, of a correct grade and analysis, for the rolling of any section from the largest bloom to the smallest and most intricate shape.

Mill operators can avoid costly experimentation and production difficulties by consulting United Roll Engineers—they are always ready to co-operate and can give valuable advice regarding the best grade of rolls to be used for any rolling operation.
DIFFUSION
COMBUSTION
SUCCESSFULLY APPLIED TO WALKING-BEAM SHEET PACK FURNACES

This SC walking beam pack furnace ... with SC Diffusion Combustion system of firing ... is installed in a large mid-western sheet mill ... capacity 12,000 lbs. of packs per hour ... high pressure natural gas utilized as fuel.

STEEL mill men have never been entirely satisfied with clear flame combustion in heating sheets for rolling ... Surface Combustion worked untiringly on the problem and evolved the answer ... Diffusion Combustion. This process imparts luminosity to a gas flame and produces a "smoky" atmosphere. A combination of clear flame burners and diffusion burners gives just the right atmosphere condition to produce soft rolling steel with a non-oxidized surface. Surface Combustion pioneers the application of Diffusion Combustion to pack furnaces with this successful installation in a large mid-western mill. Consult Surface Combustion engineers on your furnace problems.

Operated by Henry L. Domerty & Company

Surface Combustion
Surface Combustion Corporation
Toledo, Ohio

Sales and engineering service in principal cities
Frequently where a vacuum gauge is used, the measurement really desired is not vacuum but absolute pressure. Before the development of BRISTOL'S Recording Absolute Pressure Gauge, absolute pressure generally was computed by subtracting from the barometric pressure the vacuum which the vacuum indicated. Two observations, barometric pressure and vacuum, were always needed before absolute pressure itself could be determined.

Now BRISTOL presents to industry a new Recording Absolute Pressure Gauge that gives an accurate continuous 24 hour record of absolute pressure, automatically compensated for barometer fluctuations. This remarkable recorder possesses these four features:

**DIFFERENTIAL LINKAGE:**
This is essentially a cross member, pivoted at the middle to a rigid extension of the pen arm, and connected at the ends to the two sensitive actuating elements. It swings freely. It correlates the motions of the two sensitive elements, and communicates to the recording pen arm, the differential motion which is directly proportional to the absolute pressure.

**TWO SENSITIVE ACTUATING ELEMENTS:**
Both the barometer element which is hermetically sealed and the element which is connected to the vacuum are extremely sensitive to the slightest variations in pressure. These elements respond to fluctuations by expanding or contracting with a linear movement. The motions are transmitted by a suitable linkage to the pen arm.

**PEN ARM AND CHART:**
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PART II

Published the first of each month by Steel Publications Incorporated
Main Office—Thaw Building, 108 Smithfield Street, Pittsburgh, Pa.

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PUBLICATIONS INC.

EASTERN OFFICE
STEEL PUBLICATIONS INC.
29 West Thirty-fourth Street
New York, N. Y.

WESTERN MANAGER
GLEN W. SEELEY
525 North Grove Avenue
Oak Park, Ill.

Subscription Price:—In the United States, $2 per year; Canada, $3.50; all foreign countries, 20 shillings. Single Copy 25 cents. Entered as second-class mail matter at Pittsburgh, Pa., under the Act of Congress, March 3, 1879.

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Team Play

ONE of the most outstanding features of steel manufacture today is the high efficiency of operation being maintained. This high standard persists from the handling of ore to the shipment of the finished product, and is a feature of manufacture of which steel-makers may well be proud. That this condition exists is not only on account of the sharp competition now prevailing, but also because of a keen and wholesome spirit of rivalry that prevails. This is the same spirit that is found on our football fields, and is one that should be maintained, since as long as it exists there will be advancement.

Our steel mill organizations are in many respects similar to the teams that fight for athletic supremacy; they must enter the game with the determination to make good both as individuals and as members of a group. There must be, besides individual effort, group effort, or the cooperative spirit. In the field of business, as on the football field, it is equally true that a team of "stars" without cooperation can be beaten by a team composed of men of mediocre ability, but acting as a unit.

Furthermore, to carry the figure further, to achieve success both the team and the organization must be properly coached. They cannot be allowed to go "stale." Those directing the players must give some incentive to supreme action, and show a sympathetic attitude.
Silvery contours of the pass—rotating about centers at tortoise pace . . . Needle-like turnings that peel from a surface of close grained metal . . . A skilled roll turner in back of the mass, feeding a cutting edge into, what seems, an impenetrable body . . . The resultant finish, after careful check of design, paints a life story of an expected service . . . Finish is but one characteristic of a Birdsboro roll that signifies longevity. Hidden equalities do much to keep faith with their external appearance.

This is the concluding instalment in the series bearing the title: Hair Cracks on the Surface of Sheets. The information contained in the six instalments constituting this series was gathered during a long research by metallurgists and engineers who were exceptionally experienced in the work they undertook. These articles, the product of their labors, represents probably the most thorough investigation into the manufacture of sheet steel ever published. Although the primary object was to discover the cause of Hair Cracks on the Surface of Sheets, the investigation was much more comprehensive than the title implies as is readily apparent to those readers who have carefully read the paper.

Other authoritative articles on Sheet Steel manufacture will appear in this publication during 1932.

(a) The sounder surface of sheets rolled from the furnace of the armor plate mill;
(b) The better yield of sheets with sound surfaces with material from the cast steel plant;
(c) The more frequent occurrence of the defect on thicker sheets;
(d) The production of sheets with sound surfaces from cracked blooms;
(e) The appearance of cracks on sheets that were rolled from roughed blooms with perfectly sound surfaces.

These observations can be explained by the following considerations. If we take the last one first, it shows that the true cause of error must be sought behind the ingot train. In connection with this it must be considered that according to the above it is not only the rolling, but also the method of preheating the material that must have an extremely great influence on the appearance of the defect. Considered from this viewpoint, the preheating of the roughed blooms in the push furnace actually does not entirely meet the requirements that must be set up for uniform preheating of the material in order to obtain good quality.

This uniform preheating of the blooms in the push furnace is made harder because it is not possible to turn a bloom lying with the broad side on the hearth of the push furnace, because there is no manipulating device. Because of this, the flame heats the upper side more strongly than the lower. Then, after it is pushed out, it lies on the cold roll table and cools still more. Suitable tests have confirmed the correctness of this assumption. In finishing rolling as on roughing, the lower side (lying on the hearth or roll table) always showed more cracks.
We can now understand why it was possible to produce sound sheets from blooms with surface cracks. This will always be the case when, after roughing, the cracked side of the bloom is up in the push furnace, because then the shallow cracks weld together and are made harmless. This includes the corresponding test results that were made use of in order to prevent the defect on sheets from blooms that were cracked on one side.

These findings also explain the superiority of the material heated in the furnace of the armor plate mill. Here the ingots are supported, and the flames can play around them on all sides and can heat them absolutely uniformly. An important and valuable observation was that when sheets from ingots preheated in the furnace of the armor plate mill show cracks, this was generally only at places where the ingot rested on the support in the furnace. Therefore we will not be wrong if we assume that the broad side of the bloom lying on the hearth of the push furnace is injured in a similar manner.

The above also explains the superiority of the material from the second steelworks (cast steel plant) which is usually rolled only from the furnace of the armor plate mill. As already mentioned, the defect occurs here also, to an increased extent, if it is heated in the push furnace.

But the described disadvantage of the push furnace also explains the more frequent cracking of the thicker sheets. The ingots from which these sheets are rolled are naturally not roughed as strongly as ingots for thinner sheets. Therefore the ingots are much thicker, frequently twice as thick as ordinarily placed in the push furnace. It is evident that in this case the danger of irregular pre-heating is much greater, and this is even more so when, because of the positive action of push furnace operation the thicker blooms have the same heating time as the thinner.

We now can also explain why some heats tend to show this defect particularly, or why individual processes during production favor the appearance of the defect. As previously stated, the results of the main experiment show that the following circumstances facilitate the appearance of cracks:

1—Low manganese content of the bath before tapping;
2—Melting time too short;
3—Higher strength of the steel;
4—Viscosity of the steel on pouring;
5—The molds—
(a) Walls too thick,
(b) Small radius of corners;
6—Shallow position of the edge holes.

These influences act on the development of the ingot structure and indirectly on the hot-working quality of the steel. It is evident that with the frequent unfavorable loadings of surface parts of an ingot owing to the horizontal compression effects during the rolling process, the surface of an ingot will be damaged sooner if it has been weakened in the edge parts by the production method. If we investigate from this viewpoint the above mentioned influence during production, we can conclude as follows:

1—The manganese content of the heat before tapping and the melting time, are two things that are closely related to the question of the complete course of deoxidation.

The extent to which incomplete separation of the oxygen is disadvantageous for the properties of the steel during hot working has been taken up in literature many times—Oberhoffer and Elender treat this subject very thoroughly. Elender indicates incomplete deoxidation as the cause of red shortness and explains it by the assumption that during solidification, the deoxidation products are separated as finely divided slag particles which frequently cannot be seen under the microscope, which disturb the metallic cohesion. The degree of plasticity of such slag particles is of decisive importance for the behavior of the steel during hot working. The most dangerous thing is the appearance of fine thin films such as are seen with silica or alumina, similar to the sulphide films. On the other hand the spherical form assures minimum discontinuity. Tammann has proven directly the presence of an intermediate material with cadmium. But nothing more is known about this material. It might be a eutectic mixture of certain oxygen compounds. This is under the assumption that oxygen is somewhat soluble in fluid steel. Oberhoffer also assumes a certain solubility of ferrous oxide in fluid iron but without regarding the solubility question of oxygen in solid iron as decided. But it has been found that an intermediate material loosens the cohesion between the crystals. According to the results of Seidle and Schiebold, the presence of intermediate material in the crystals of the broad sides of the sheet blooms perpendicular to the direction of rolling (unfavorable location) is more effective than when parallel to the rolling direction, that
is, at the narrow sides of the blooms. The greater the amount of intermediate material between the blooms, the greater will be the tendency to crack, that is, there is less resistance to the mechanical stressing on rolling. Monden also was able to trace many defects in finished steel (especially poor workability when red hot) to insufficient deoxidation, but was not able to support this in a general way by figures or tests.

2—The greater tendency for material with higher strengths to form surface cracks can be explained sufficiently by the more difficult pouring and the necessarily lower rolling temperatures of such kinds of mild steel.

3—The observation that heats that were viscous on pouring, and ingots that for any reason have a shallow blowhole ring, show the surface defect more frequently, is covered by the works of Monden, according to which the kind and position of the blowhole ring is an important factor in the workability of the ingot. According to Monden's observations, the best ingots on rolling were actually those that had a thick edge layer free from blowholes, with a ring below it of comparatively few large blowholes. Sattmann also found a limit for the permissible reduction in height and rolling temperature, which is shifted according to the greater or less cohesion of the material, and is exceeded sooner with material with blowholes than with uniformly dense material.

4—The effect of the shape of the mold, that is, the wall thickness and radius of curvature of the corners, on the behavior of the ingots during hot working, can be seen from literature on the subject. We have already taken this up.

In addition to what was stated previously on the different yields of sound sheets from ingots III and X, it can be said that these differences can be caused by the following phenomena during working:

(a) If, in the two shapes of ingots we compare the size of the broad sides that determine the heat losses by radiation, and particularly by conduction, we do not find great differences. The broad sides in ingot III are about 25 per cent smaller, and accordingly the heat losses from the surface are smaller.

(b) The widening will be different with the two shapes of ingot. According to Meerbach the widening is greater as the ratio of roll diameter to ingot thickness is greater. This can be explained by the fact that with larger roll diameter and smaller ingot thickness, the rolling process approximates a pressing process in which the material is uniformly displaced in all directions. On comparing the corresponding ingot shapes we get the following ratios of roll diameter to ingot thickness—

For four-sided ingot III about 1.8,
For rectangular ingot X about 2.0.

Ingot III is superior to ingot X because it has less tendency to broaden.

(c) Since nothing but thin sheets were rolled from ingot III, it was rolled to a thickness of 80 to 100 mm., while the roughed blooms from X, from which most of the thicker sheets were made, averaged 130 mm. and more. As already stated, under the given conditions this is a further disadvantage of ingot from mold X, since with the thicker blooms their complete uniform heating in the push furnace is more difficult.

Experiments to Test the Assumed Cause of the Defect

The assumptions, developed in the previous section, on the formation of surface hair cracks on sheets, are in accordance with the results of all tests and are based on all the observations that were made on the occurrence of the defect.

Accordingly the surface cracks on sheets are not a defect in material, but a defect in working. They are caused by unfavorable ratios of rolling pressure to rolling temperature, and also on the fact that because of differences in the temperature of the surface and core of the ingot, serious conditions arise that cause a physical overstressing of the surface parts and finally a cracking of the surface. These assumptions are not contradicted, but are supported by metallographic investigations. If they are correct it must be possible to cause surface cracks artificially. For this reason we made the following investigations in which it was attempted to study the complete rolling of the roughed blooms more thoroughly, and to trace the appearance of the defect accurately.

Rolling with Constant Reduction Pressures

As already stated, the sheet ingots on roughing were rolled with approximately constant reduction pressures of about 30 mm. In order to study the

Fig. 28—Effect of irregular cooling on the formation of cracks on the surface. (Left) Lower broad side of bloom placed on the roll table. (Right) Upper broad side of bloom not placed on the roll table
The effect of this method of rolling on the stressing of the material, dial gages were used (Puppe method) and the total roll pressures as well as K-values were determined during the rolling of two sheets of ingots. Fig. 27 is the rolling diagrams of ingot III of heat 5484 (0.18 per cent C, 0.55 per cent Mn, 0.045 per cent P, 0.032 per cent S, 45.0 kg. strength and 21.0 per cent elongation). It is plainly seen, as with constant reduction height, in spite of the comparatively slight temperature drop, the roll pressure increases as rolling progresses, and rises greatly at the end of rolling. In conformity with this, the two test ingots crack at the edges and end surfaces after the twelfth pass.

Rolling with Decreasing Reduction Pressures

In order to see whether the method of rolling, as assumed previously, would influence the cracking of the surface, ingot V of heat 5565 (0.09 per cent C, 0.47 per cent Mn, 0.05 per cent P, 0.023 per cent S, 37.7 kg. strength and 25.5 per cent elongation) was rolled as usual, that is, with constant reduction in height. The bloom, as well as the sheet rolled from it, was cracked on both sides. Ingot VI from the same heat, which was roughed with decreasing pressures corresponding to a pass plan corresponding to the temperature drop, did not crack at the surface. Also, the sheets from ingots VII and VIII, which were heated in the furnace of the armor plate mill and rolled in one heat, were good.

According to this, by suitable selection of the reduction pressures we can avoid overstressing the material, which must lead to the crack formation. Accordingly, steps were taken so that in the future on roughing sheet ingots, the work must be done with decreasing reduction pressures when using high initial temperatures and a simultaneous reduction in the total rolling time.

Artificial Production of the Defect

The following tests were made in order to show the correctness of the assumption that cracks can form on the surface when there are large temperature differences in the material.

The last ingot from heat 5504 (0.010 per cent C, 0.50 per cent Mn, 0.033 per cent P, 0.040 per cent S, 40.4 kg. strength and 24.5 per cent elongation) which had proved to be very good on roughing and gave blooms only two of which showed fine edge cracks, were removed from the reheating furnace at about 1300 deg. In order to increase the temperature difference between surface and core, the ingot was allowed to rest about 6 minutes on the manipulator before rolling, and then it was rolled with constant reductions in height of about 40 mm. After the sixth flat pass the first cracks could be seen in the vicinity of the edges, and they become larger and more frequent with each pass. After the ninth pass the rolling was stopped and the bloom was set aside for metallographic investigation. Fig. 28 shows the two broad sides of the bloom after the ninth pass. The cracks are plainly visible. Fig. 29 (a section perpendicular to the surface of the bloom) shows the position and depth of the surface cracks and the edge blowholes which are somewhat flattened by the rolling process, but are not welded together. There is no connection between this and the surface. Figs. 30 and 31 are higher magnifications of the surface cracks. Their development is exactly like the defect shown earlier in the description of the metallographic investigations. The cracks here are also filled with oxides. The assertion made at that time, that the oxide inclusions are not the cause, but only the result of cracking of the originally oxide-free surface, is thus shown to be correct from the findings of the metallographical investigations of the cracks that were produced arbitrarily.

In order to see whether the above result is not an accident, the same test was repeated with five more heats, totalling 23 ingots. The 23 test ingots, that is, those that were allowed to remain on the manipulator two minutes before rolling, were all cracked on both side edges and surfaces; on the other hand only six (26 per cent) of the 21 ingots from the same heats rolled in accordance with the rolling plan, showed very slight surface cracks on one side. This
shows perfectly that greater temperature differences between ingot surface and core result in cracking of the surface.

Comparison of Rolling on the Two-high Coarse Sheet Mill and on the Armor-plate Mill

Effect of the conveying time for the heated ingot — This test was intended as a supplement of the above experiment, in order to show that a long time in conveying the preheated material from the furnace to the train is disadvantageous because of the surface cooling thus caused. For this purpose ingots from two heats No. 5658 (0.10 per cent C, 0.44 per cent Mn, 0.035 per cent P, 0.030 per cent S, 38.2 kg. strength and 19.5 per cent elongation) and No. 7662 (0.09 per cent C, 0.45 per cent Mn, 0.034 per cent P, 0.023 per cent S, 39.4 kg. strength and 23.0 per cent elongation) were roughed according to the rolling plan, placed in the push furnace, thoroughly heated, and then some were rolled on the two-high coarse sheet mill connected with the furnace by a roll table, and others were rolled on the armor-plate mill somewhat further away. This test, in which we also observed the side of the sheet (relative to the position of the bloom in the push furnace) showing the defect, gave the following result: Of the seven sheets rolled on the two-high coarse sheet mill, there were no cracks on the upper side turned toward the flame in the furnace, while three sheets were slightly cracked on the under side. On the other hand, of the seven sheets rolled on the armor-plate mill, two showed cracks on the upper side and all on the lower side. This is striking proof of the correctness of the assumptions. The surface defect is caused by:

1—Non-uniform heating of the two broad surfaces of the roughed blooms.
2—Any increase in the temperature difference between surface and core of the preheated material.

Rolling at Low Temperatures

This experiment was for the purpose of testing the assertion that the actual rolling temperature and the rolling pressure do not determine the cracking of the surface of the material, but the ratio of these two influences does. If this assumption is correct then it must be possible to roll material with sound surfaces at comparatively low temperature (assuming good heats) if the rolling pressure is chosen according to the temperature of the material, thus avoiding physical overstressing of the material. In order to test this, an ingot was roughed at an extraordinarily low temperature (about 1000 deg. C.) from each of two heats, one soft and one hard, No. 6031 (0.09 per cent C, 0.47 per cent Mn, 0.030 per cent P, 0.080 per cent S, 35.9 kg. strength and 27.0 per cent elongation and No. 6032 (0.32 per cent C, 0.73 per cent Mn, 0.041 per cent P, 0.051 per cent S, 0.18 per cent Si, 56.4 kg. strength and 17.0 per cent elongation). The rolling was done with decreasing reductions in thickness, corresponding to the temperature of the ingot. The final rolling was likewise on blooms most carefully pre-heated uniformly. The roughed blooms as well as the finished sheets from the two ingots had perfectly sound surfaces.

Accordingly this shows that even with low rolling temperatures, if the pressure is properly chosen, it is possible to avoid an overstressing of the material that leads to the formation of cracks.

This test concludes the series of investigations that had to be made in order to prove the correctness of the assumptions that were previously made in order to explain the formation of the surface defect. All the assumptions were confirmed by the results of the investigations pertaining to them. Before concluding the paper the author wishes to thank the head of the steel works, chief inspector A. Rotter, for the fundamental suggestions in making the experiment in the steelworks.

Application

Assuming that in the steelworks there is careful deoxidation of the steel, proper selection of the mold and casting of a dense ingot with a low blowhole ring, in order to prevent the formation of hair cracks on sheets, the crude ingot as well as the roughed ingot in the rolling mill must be most carefully preheated uniformly. Special attention must be given the preheating of the blooms in the push furnace if there is no manipulator. The surface cooling of the material, which causes temperature differences between the surface and interior of the piece, must be prevented as far as possible.

Physical overstressing of the surface of the material must be avoided by proper selection of the ratio of roll pressure to rolling temperature.

Summary

In order to investigate the causes of the formation of hair cracks on sheets, preliminary and main tests were made during the production of the steel and its working by rolling. These tests were described in detail and their results were shown in tables and illustrations. The conclusions and applications were discussed and the principal cause of the formation of cracks was found to be a great temperature difference between the surface and interior of the material rolled. Therefore it must be demanded that the crude ingot as well as the roughed ingot be most carefully preheated absolutely uniformly in all parts, and that any great temperature difference between surface and core be avoided during the conveying of the crude and roughed ingots to the rolls. Finally, by proper selection of the ratio of roll pressure to rolling temperature, care must be taken that the surface parts of the material are not overstressed.

Reference

61 LOC. CIT., P. 170.
63 LOC. CIT., P. 173-4.
64 THE ACTION OF NON-HOMOEOTIC ALUMINUM CAST INGOTS ON COLD ROLLING. Z. F. METALLK, 1925, V. 17, P. 221-6, 283-8, 320-365-8.
65 LOC. CIT., P. 68.
Slab Mill driven by

Three Reversing Motors

The 44-in. reversing universal slabbing mill, placed in service at a large Chicago district steel plant during April 1930, is notable because of its very large size and high tonnage capacity, and particularly because of the unique method of electrical drive utilizing three d.c. reversing motors. Ingots up to 30 in. x 64 in. in cross section, and weighing as much as 40,000 lb. can be rolled, and it is estimated that slabs 60 in. wide by 4 in. thick can be produced at a maximum rate of 400 tons per hour. The three reversing motors driving the horizontal and vertical rolls have a total continuous capacity of 12,500 hp. and a maximum emergency capacity of about 35,000 hp., nearly a third greater than on any similar mill.

The main horizontal rolls are driven directly and without pinions by a 10,000-hp. twin-motor drive, consisting of two double armature 5,000-hp., 700-volt, 40/80-r.p.m., d.c., reversing motors. The double armature design permits the use of machines of small diameter so that the two motors can be installed with a vertical center to center distance of less than 7 ft. with resulting conservative operating angles for the spindle couplings. The small diameter armatures also have a great deal lower WR than would large diameter single armatures so that less torque is necessary for a given acceleration rate and a greater net torque is available for rolling the steel. Each motor has a maximum emergency torque capacity of 1,970,000 lb.-ft. at speeds below the full field speed, and the two motors have a combined maximum torque of 3,940,000 lb.-ft. corresponding to a peak capacity of 28,000 hp. at 37 r.p.m.

The two horizontal roll motors are mechanically duplicate, and each is complete with rugged steel bedplate, two pedestal bearings, and shaft with forged flange half coupling. The coupling end pedestals are cast steel, well anchored to the foundations, and provided with babbitted thrust surfaces to absorb the thrust set up by a broken spindle or other accident. A long jack shaft connects the upper motor to the mill spindle. This jack shaft is supported at the mill end by a pedestal bearing; similar to the motor bearings, the bearing pedestal being mounted on a cast steel support which straddles the mill end pedestal of the lower motor. The driving halves of the universal couplings on the mill spindles are bolted to the forged flange half couplings on the upper motor jack shaft and lower motor armature shaft, respectively.

Fig. 1 (Left)—General view of 44-in. universal slabbing mill, showing manipulators, horizontal roll stand, and spindles and couplings connecting to the three driving motors. Fig. 2 (Right)—General view of the delivery side of the 44-in. reversing slabbing mill, showing arrangement and drive of vertical edging rolls.
The mill spindles are 31 ft. long from center to center of the universal couplings. The center of the lower roll is approximately 12 in. above the center of the lower 5,000-hp. motor, and the lower spindle therefore operates at a fixed angle of about 1.85 deg. The center to center distance between the upper and lower motors is 83\(\frac{1}{2}\) in., and the maximum lift of the upper roll is approximately 45 in., so that with 44 in. diameter rolls the upper spindle operates through a range of from 2.70 deg. above the horizontal to 3.75 deg. below the horizontal, the normal working angles always being considerably smaller than these maximum values.

**Drives for Edging Rolls**

The vertical edging rolls are driven, through reduction and miter gearing, by a 2500-hp., 700-volt, 79/225-r.p.m. single armature, reversing motor. This motor is also built with a small diameter, long core armature to allow location of the vertical rolls close to the horizontal rolls, and also to keep the WR\(^2\) a minimum to permit acceleration rates correspondingly similar to those of the horizontal roll motors. The 2,500-hp. motor has a maximum emergency torque capacity of 500,000 lb.-ft. at speeds up to about 74 r.p.m.

The three reversing motors are connected in parallel and supplied with variable voltage d.c. power from a five unit six bearing flywheel motor generator set, consisting of three 3,500 kw., 700 volt, compound wound generators, connected in parallel, a 6,500-hp., 3-phase, 25-cycle, 6600-volt, 370-r.p.m., wound rotor induction motor, and a 180,000 lb., 15 ft. 0 in. diameter steel plate flywheel. When running at the synchronous speed of 375 r.p.m. the rotating parts of the set have a total stored energy of approximately 270,000 hp.-sec. All bearings are equipped with oil rings, and are also fed from a circulating oiling system. The large, heavily loaded flywheel bearings are cooled by flooding with several gallons of fresh oil per minute, thus making it unnecessary to use separate water cooling.

The motor room and electrical equipment are cooled by a closed, recirculating ventilation system. Two 85,000-c.f.m. centrifugal fans, driven by 150-hp., 3-phase, 25-cycle, 440-volt, 715-r.p.m. squirrel cage induction motors, draw air from the pits under the motor generator set, and discharge through a 26,850 sq. ft. surface air cooler and ducts to the rear end bells of the three reversing motors. From the reversing motors the air discharges into the motor room and is drawn through the motor generator set to the pits and again cooled and recirculated. A 50,000-c.f.m. fan draws outside air through an oil coated type self cleaning air filter, and discharges into the motor room, to supply makeup air to compensate for leaks and to maintain the room under positive pressure to prevent the infiltration of dirt. Using 1,350 gal. of 70 deg. F. water per minute, the cooler can dissipate approximately 1,800 kw. loss, and maintain the temperature of the motor room below 105 deg. F., when the equipment is carrying the estimated average load imposed by the rolling of 64 in. x 30 in.—38,000-lb. ingots to 60 in. x 4 in. slabs at the rate of 400 gross tons of ingots per hour.

With a spacing of about 7 ft. between the main horizontal rolls and the vertical edging rolls, the two sets of rolls work simultaneously on the same bar and the three motors must have the proper relative speeds at all times in order to prevent tearing the steel and to prevent interchange of power between the motors. The main shunt fields of the two 5,000 hp. horizonal roll motors are connected in series and separately excited from the two main field exciters. These motors are also provided with cumulative and crossed differential variable potential compounding field windings, excited from two series exciters. Thus any tendency of either 5000-hp. motor to take more than its share of the horizontal mill load will cause the excitation of that motor to be increased and the excitation of the other motor to be reduced, thus providing an inherently load balancing characteristic. If the two horizontal rolls are of different diameters they must obviously rotate at unequal speeds in order to work on the top and bottom of the same bar. The above described interconnection of the 5,000-hp. motor (Continued on page 1571)

**Fig. 3**—12,500-hp. drive of 44-in. slabbing mill. In the foreground are the two 5,000-hp. double armature motors, constituting the twin-motor drive for the horizontal rolls, and in the upper background is the 2,500-hp. motor driving the vertical edging rolls.

**Fig. 4**—General view of 44-in. slabbing mill motor room. In the foreground is the 5,000-hp motor driving the upper horizontal roll, and in the background is the 10,500-kw. flywheel motor generator set which supplies power to the three reversing motors.
Blast Furnace Efficiency

A comparison is made between present practice and that of 1924

By S. P. KINNEY
H. A. Brassert Company

In 1924 the U. S. Bureau of Mines, in connection with its blast furnace studies, made a survey of a number of blast furnace plants for the purpose of constructing a heat balance representative of American practice.* Thermal balances of 14 American furnaces were made.

It is the purpose of this paper to present a heat balance of present modern American operation and compare the results of this with the average heat balance from the 14 American furnaces made in 1924. Numerous improvements have taken place in blast furnace design and practice since the average balance of the 14 furnaces was constructed. These advances have had an effect on the practice and the result of their inauguration is reflected in the thermal balance of the more modern American furnace. Incidentally, the hearth diameters have still further increased and finally in some cases at least, the stockline and bell diameters have been substantially enlarged.

Increased Stock Line Diameter

Increase in the diameter of the stock line has finally followed the larger hearth diameter. It has been recognized that increased hearth diameter must necessarily be followed by an increased stock line diameter. Where the hearth diameter was increased without an accompanying enlargement of the stock line, a marked increase in flue dust production was noted.

The increase in production of flue dust could be attributed directly to the increase in velocity and channelling on the walls, and therefore the increased carrying power of the gases ascending in the shaft of the furnace. This condition results not only in increased production of flue dust, but also in increased temperatures at the stock line of the furnace and excessive wear of the inwall. These conditions resulted in unsatisfactory practice too early in the furnace campaign. In a number of cases it was found necessary to shut down the furnace for stock line repair.

Venturi Throat

The venturi throat is rapidly gaining recognition as a simple and efficient means of increasing stock line diameter and reducing dust losses. Flaring of the top of the shaft from a point well below the top of the stock accomplishes several beneficial results: 1—Flue dust production is decreased owing to the increased diameter and decreased gas velocity; 2—the inwall is amply protected owing to the outward flare in the vicinity of the stock line; 3—

There is a more efficient gas-solid contact in the upper portion of the shaft produced by the change in the lines of flow of the stock and gas resulting from the inward batter of the wall at some distance below the stock-line. This improvement in gas-solid contact in the upper part of the shaft has a marked effect in decreasing the top temperature, fuel consumption and uniform working of the furnace.

Eichenberg Process

The Eichenberg process for the reduction of flue dust has been adopted for many furnaces in Europe. The method used by Eichenberg consists in forming a rotating screen or curtain of gas and water at right angles to the upward flow of the gas. This screen is formed just above the stock line by using tangential jets of gas and water. The use of this method has effected a dust reduction of 30 to 50 per cent in plants using this system.

The illustration indicates the method used in the Eichenberg process. The blast furnace gas and water which is employed in forming the screen above the stock line is injected into the furnace tangentially, as shown on this plan. Atomizing sprays of a certain coarseness are used to produce the greatest kinetic energy. Gas and water are supplied at the top of the furnace through circle pipes in measured quantities. The uniform supply of the correct amount of water to the charges is in itself an important improvement toward regularity of stock conditions as compared to the present method of wetting the ore in the skip buckets without accurate means of control.

Stock Line Recorders

Maintenance of the stock line at a constant height is a necessity in uniform blast furnace operation. Investigations in the shaft of the furnace have shown that a change in the height of the stock column is reflected in a change in the flow of the stock in the column. These relations have also been studied in detail on models. A chart taken from an operating furnace equipped with a four rod stock line recorder is here shown.

This chart shows a typical record of the movement of the stock column on a normally operating blast furnace. It gives a check at all times on how the material is distributed in the furnace and whether or not the furnace is working uniform circumferentially. It enables the operator to correct the distribution of the material if it is at fault, or to change the blast distribution at the bottom of the furnace, which might be the cause for irregular stock descent. For this reason the blast and top pressure of the furnace are also recorded together with the stock line. With this information on one continuous chart the charging operation and their effect on top pressure and blast pressure can readily be noted.

Correct and reliable stock line records depend to a great extent upon smooth movement of the test rods through the inlet holes at the top of the furnace. The rods which normally rest on the stock are raised only when new material is discharged from the big bell. However when the rods are lowered and the furnace slips they sometimes become wedged in the stock which causes them to bend. Clogging of the inlets with flue dust is another trouble often encountered. A new design of the testing member has overcome these difficulties, which also has the advantage that it has a greatly enlarged supporting surface which prevents it from settling between the material; therefore a correct indication of the stock line is assured. It also has a perfect seal which prevents the escape of gases into the atmosphere and helps to maintain a clean furnace top. The use of steam applied to seal the bell rods, in connection with the sealed test holes, makes the maintenance of a clean furnace top possible.

Mud Guns

The recently developed, electrically operated automatic mud gun has effected a greater benefit to blast furnace operation than any other single piece
Photograph of a chart of a 4-rod unit continuous stock line recorder. (Record lines appear in colors indicated. Actual width = 12 in.)

Use of the automatic mud gun provides a means of stopping the hole without taking off the blast. This prevents undue settlement of the stock. Equilibrium of the stock column is not disturbed. This was clearly shown in an investigation, where it was found that the average rate of stock descent, prior to cast was 2.78 in. per minute, during cast up until the time the blast went off 4.3 in. per minute, after the blast went off the stock column settled 58 in. Accelerated settlement of the stock during cast cannot be obviated, but the use of a gun to stop the hole without taking off the wind prevents the slip at the end of the cast. This slip at the end of the cast retards furnace operation and delays uniform movement of the stock after cast for a period of 45 minutes to 1 hour.

The electric automatic mud gun developed at the Gary plant is mounted on a turret near the furnace and is electrically operated. Instead of having a steam driven piston, as has been commonly used, the piston is electrically driven by means of a screw. This screw is fully protected from the mud and is operated in oil. The gun is remotely controlled and is swung into place in front of the furnace by means of steam cylinders, which are remotely mounted in a convenient place in the cast house.

Continuous operation of the gun has shown that its maintenance is lower than any other gun which has been developed so far. This is due mainly to the heavy construction of the gun and to the fact

Heat Balance

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<td>Per cent</td>
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<tr>
<td>Dissociation of moisture</td>
<td>960,320</td>
<td>5.9</td>
<td>940,500</td>
<td>6.8</td>
</tr>
<tr>
<td>Sensible heat of metal</td>
<td>1,125,050</td>
<td>6.6</td>
<td>1,142,400</td>
<td>8.3</td>
</tr>
<tr>
<td>Sensible heat of slag</td>
<td>1,281,000</td>
<td>7.8</td>
<td>940,500</td>
<td>6.8</td>
</tr>
<tr>
<td>Sensible heat top gases (dry)</td>
<td>656,710</td>
<td>4.0</td>
<td>745,976</td>
<td>5.4</td>
</tr>
<tr>
<td>Sensible heat moisture in top gases</td>
<td>623,290</td>
<td>3.8</td>
<td>548,822</td>
<td>4.1</td>
</tr>
<tr>
<td>Total heat accounted for</td>
<td>13,192,100</td>
<td>81.0</td>
<td>12,256,036</td>
<td>89.1</td>
</tr>
<tr>
<td>Heat unaccounted for</td>
<td>3,090,700</td>
<td>19.0</td>
<td>1,493,938</td>
<td>10.9</td>
</tr>
<tr>
<td></td>
<td>16,282,800</td>
<td>100.0</td>
<td>13,749,974</td>
<td>100.0</td>
</tr>
</tbody>
</table>
that the screw driving the piston is fully protected from the clay. The gun is operated against the full pressure of the furnace and continuous use has shown that no operating delays may be expected from the use of this gun.

**Comparison of Heat Balances**

The following tabulation gives two heat balances. No. 1 computed from the operating data of 14 American furnaces operating on Mesabi practice in 1924. The details of the computations and operating data for these furnaces are given in full in the published literature. It is probably sufficient to state here that the average operating data indicated a coke consumption of 2,000 lb. per ton of iron; slag produced was 1045 lb. per ton, blast temperature was 1012 deg. F., top temperature 337 deg. F. The average analysis of the top gas was as follows:

<table>
<thead>
<tr>
<th>Per cent by volume</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>26.0</td>
</tr>
<tr>
<td>CO</td>
<td>12.9</td>
</tr>
<tr>
<td>H₂</td>
<td>2.9</td>
</tr>
<tr>
<td>N₂</td>
<td>58.3</td>
</tr>
</tbody>
</table>

In balance No. 2 for the modern furnace the practice is practically the same, with the exception that owing to the use of zoned checkers in the stoves the blast temperature employed is 1600 deg. F. Increase in the shaft efficiency, owing to increased diameter of the top, has resulted in better gas-solid contact and in turn, a top gas with a greater carbon dioxide content. These factors have resulted in a coke consumption of 1750 lb. per ton of iron. The composition of the top gas follows:

<table>
<thead>
<tr>
<th>Per cent by volume</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>15.3</td>
</tr>
<tr>
<td>CO</td>
<td>24.5</td>
</tr>
<tr>
<td>H₂</td>
<td>3.5</td>
</tr>
<tr>
<td>CH₄</td>
<td>0.2</td>
</tr>
<tr>
<td>N₂</td>
<td>56.5</td>
</tr>
</tbody>
</table>

Blast Furnace Stoves

The results are accomplished through the use of fine cleaned gas on small checkered high efficiency stoves. By the adoption of the principle of uniform velocity and the promotion of turbulence, stove efficiencies have been increased from 60 or 65 to 80 or 90 per cent according to the particular operation. This increase in efficiency has provided a blast temperature of 1600 deg. F. with the expenditure of less energy than was consumed in 1924 to produce a temperature of 1000 deg. F. From the tabulation which follows showing the comparison of heat balances it may be shown that in 1924

\[
\frac{2.69 \times 10^6}{60\%} = 3.48 \times 10^6
\]

B.t.u. were required per ton of iron to raise the blast to 1000 deg. F. at an efficiency of 60 per cent.

Blast temperatures of 1600 deg. F. are now being obtained by the expenditure of

\[
\frac{2.79 \times 10^6}{85\%} = 3.18 \times 10^6
\]

which represents less than 20 per cent of the gas produced compared with approximately 30 per cent which has been used in the past.

There are now some 54 high efficiency fine checkered stoves employing the principle of uniform velocity and turbulent flow in operation. Experience has shown that gas having a cleanliness of .02 grains of dust per cubic foot is amply clean for their efficient operation and maintenance.

**Blast Furnace Efficiency**

The foregoing balance indicates an improvement in practice in the past seven years. Of the total heat accounted for in the shaft 89 per cent as compared with 81 per cent may be accounted for. Fifty-three per cent (as compared with 46 per cent) is now used for the reduction of the oxides.

**Blast Furnace Boilers**

Recent developments have been effected in the use of blast-furnace gas for steam raising purposes. The ordinary old-type blast furnace boiler using primary cleaned blast furnace gas operated at an efficiency ranging from 40 to 65 per cent. Recently marked advances have been made in the burning of blast-furnace gas in steam generating units operating at high efficiencies. One company has developed a boiler using blast furnace gas which is fired tangentially through tuyeres at the four corners of a square combustion chamber. It has been found that clean blast-furnace gas has materially affected the efficiency of steam generating units. An increase of approximately 30 per cent in the efficiency of these units has been attained by better methods of heat transfer and the use of blast-furnace gas which has been previously cleaned. Overall efficiency of this particular operating unit ranged from 81 to 85 per cent. The arrangement of the burners and the shape of the combustion chamber produce turbulent mixing.
Technically a metallurgical process possesses no virtue, nor is it lacking in virtue, by being fast or slow. The essential points are whether the process is controllable, how quickly this control can be exercised, and how rapid is the response. The situation in Bessemer some years back, compared with Bessemer today, is somewhat like the situation with respect to automobile speed. Twenty-five miles an hour might have been a fair average road speed years ago; a driver did not have good roads and he was uncertain about his machine and himself. Today where there is no legal maximum speed the average road speed may be 50 miles, but the driver has a concrete road protected at crossings, has a machine the performance of which is reliable, and he has trained himself to react correctly and rapidly to the road situations which develop. The Bessemer process has done a similar thing during the same time, but in the case of the Bessemer process the accomplishment has been with respect to uniformity and quality of product.

Of course, to obtain quality and uniformity of product, the raw material from which the product is made should also exhibit these properties. With the improvement in blast furnace practice that characterizes the past 25 years, there has been a much greater regularity of grade of Bessemer pig than was obtained before that time. Figs. 4 to 7 show the frequency curves during one year of silicon, sulphur, phosphorus and manganese. Composition for the particular element is plotted against percentage number of casts of a definite analysis. About 10,000 casts are represented from two plants, one in the Pittsburgh district and the other in the Chicago district. When the variation of composition of particular ores and of ore mixtures and of fuels are considered, as well as the variation in blast furnace practice affected by different economic factors prevailing in different districts, these diagrams show a remarkable regularity of product over such a long period as a year.

These frequency curves are plotted as follows: the data for the year is arranged in order of change in chemical composition. The number of casts of a particular composition is indicated in the tabulation. Then beginning with the lowest percentage composition, the number of casts of that composition are plotted as verticals against a base line scaling the composition. Each unit of composition has a vertical plotted which represents the number of casts. The lower curve in each figure from Fig. 4 to Fig. 7 shows the graph of this plot. In other words if it is desired to know the number of casts of a certain composition that have been made, the figure for the proper composition would be selected and then the vertical from this point to the lower curve will give the number of casts of that particular composition or by reading a proper scale the percentage number of such casts. The upper curve in each of Figs. 4 to 7 is the cumulative frequency curve and is obtained from the first curve. To the number of casts of the lowest chemical composition is added the number of casts of the next lowest composition and this point is plotted as a vertical. To the number last obtained is added the number of casts of the third lowest composition and this point is plotted and so on till the full number of casts have been added and plotted. The slope of this cumulative frequency curve is a measure of uniformity of composition. The steeper the slope, the more uniform is the composition. The less the slope, the greater is the variation in composition.
To produce the best quality Bessemer steel, it is necessary not only to have a uniform quality raw material, the iron, and to carry out the process itself by the intelligent exercise of all those elements of control now available, but this same good judgment and intelligent direction must be similarly applied in the pouring, recarburization, teeming, soaking pit and rolling practice. Just as one illustration of this, the ductility factors of Bessemer steel are not the same as the chemically corresponding grades of steel made by other processes for other kinds of steel. In drawing Bessemer steel wires, they can be reduced from No. 5 rod to No. 19 or 20 gage without annealing, whereas open-hearth steel for the same purposes would require two or three anneals for the same reduction. There are somewhat similar variations in the hot ductility or hot working properties. On account of this difference in hot ductility or hot working factors, the rolling mill practice particularly must be adapted to the rolling of Bessemer steel to get the best results and this involves not only the rolling, but the proper heating in the soaking pits.

The pouring of the converter blown metal into the ladle is carried out in such a manner as to obtain in the bath complete mixing of the manganese, silicon and carbon which are added during the pour. Usually this is done by beginning the addition of the deoxidizer or recarburizer when about a quarter of the heat has been poured into the ladle, having the addition completed when the ladle is half full and securing maximum mixing effect while the last half of the heat is poured in. For certain grades of soft steel the ladle is held a specified time before teeming to permit the completion of reactions.

To get the uniformity obtainable by use of large heats, in one of the Bessemer plants a practice has been developed of pouring two successive blows into one large ladle. The silicon and manganese is added to the first blow while it is being poured into the ladle and the second blow metal is then poured in to secure the maximum stirring and mixing. There is obtained in this way a more uniform quality of metal. The large converter, referred to later, attempts to attain this greater uniformity by increase of size.

**Table A—Analyses of Various Bessemer Steel Products**

<table>
<thead>
<tr>
<th>Soft Bessemer Grades</th>
<th>C</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skelp</td>
<td>.06-.08</td>
<td>.35-.45</td>
<td>.090</td>
<td>.045</td>
</tr>
<tr>
<td>Soft wire</td>
<td>.06</td>
<td>.30 max.</td>
<td>.10 max.</td>
<td>.05 max.</td>
</tr>
<tr>
<td>Medium wire</td>
<td>.07-.10</td>
<td>.30-.45</td>
<td>.110 max.</td>
<td>.08 max.</td>
</tr>
<tr>
<td>Hard wire</td>
<td>.12-.16</td>
<td>.80-.90</td>
<td>.110 max.</td>
<td>.08 max.</td>
</tr>
<tr>
<td>Sheet and tin</td>
<td>.08</td>
<td>.40</td>
<td>.100</td>
<td>.040</td>
</tr>
<tr>
<td>Screw stock</td>
<td>.08-.12</td>
<td>.70-.90</td>
<td>.08-.12</td>
<td>.10 min.</td>
</tr>
<tr>
<td>Screw stock Spec.</td>
<td>.08-.16</td>
<td>.75-.10</td>
<td>.08-.12</td>
<td>.20-.30</td>
</tr>
<tr>
<td>Screw stock A.S.T.M.</td>
<td>.08-.16</td>
<td>.60-.90</td>
<td>.09-.13</td>
<td>.10-.18</td>
</tr>
<tr>
<td>Screw stock G.M.C.</td>
<td>.08-.16</td>
<td>.70-.90</td>
<td>.09-.13</td>
<td>.10-.15</td>
</tr>
<tr>
<td>Screw stock S.A.E.1120</td>
<td>.08-.16</td>
<td>.60-.80</td>
<td>.09-.13</td>
<td>.075-.15</td>
</tr>
</tbody>
</table>

Per Cent Silicon

- Silicon content of pig iron, Pittsburgh District

- Silicon content of pig iron, Chicago District

- Silicon content, Chicago District

- Sulphur content, Pittsburgh District

- Sulphur content, Pittsburgh District

**Ingot Practice**

Ingot practice has been much improved in Bessemer with the use of heavier molds of such designs as to secure the best ingot surface and of such cross section as to obtain regulated solidification with least internal stress and to secure thorough mechanical working of the metal during rolling.

Many of these details may appear to be small things and perhaps trivial, but they have been recognized as controllable elements entering into quality and uniformity of product which results from the sum total of these small items. As soon as a factor affecting quality becomes controllable then improvement of quality can be secured.

For certain purposes, Bessemer steel has characteristics which it is generally admitted make it more desirable than any
other material. These characteristics of soft Bessemer steels are weldability, machineability and stiffness.

The largest uses of Bessemer steel at the present time in this country are in the manufacture of skelp for welded tubes, sheet steel and tinplate, screw stock, wire, hoop and automotive forging stock. These products in which Bessemer has either maintained or strengthened its position will be considered briefly. Typical analyses of them are given in Table A. It will be noted that almost all of them are of very low carbon content and many are of very low silicon content. To produce such low carbon low silicon metal, it is not necessary to have high manganese, because special soft Bessemer metal is made with C .02, Si .002 and Mn .01 and for certain uses has been highly satisfactory. Metallurgically, this fact that it is the very low carbon content Bessemer steels that have maintained their ascendancy, is very interesting. It happens that these steels are the most difficult to make, because of the nicety of control that must be exercised. When at the present time that exactness of control has been obtained in Bessemer, so that these Bessemer steels cannot be displaced by steels made in other ways, it shows that a remarkable development has taken place within recent years.

Besides the characteristic analysis of the Bessemer steel, there is another point to be noted, which is, that the product of the converter is very often worked up to a mill product which is employed in the manufacture of a finished product by the use of automatic or semi-automatic machinery, where uniformity of quality and of size or weight is an absolute necessity. In fact uniformity is the prime necessity of manufacture by automatic machinery.

In the beginning of this paper the point was stressed that present day Bessemer is produced under conditions very favorable for close quality control and for maintenance of uniformity of quality. The fact that Bessemer steel is specified by users and is furnished them of such typical analyses as shown in Table A indicates that it is entirely satisfying the rigorous requirements of these users of steel who knowingly specify it for fabrication where forming, shaping, drawing, welding and machining, in many cases with automatic machines, are among the most severe uses to which steel can be put. The greater stiffness of these Bessemer steels is a decided advantage too in certain enamelling operations where it decidedly decreases warpage.

There is a large tonnage of steel sold now for which the user does not specify the method of manufacture. In any fabrication which involves at any place the operations of welding, forging or machining, or of all combined, the use of Bessemer steel is at least indicated. If for any reason, including the above, a low carbon steel is desired but with greater stiffness than ordinary, then the use of Bessemer steel is again indicated. These inherent advantages of Bessemer steel over other steels have been discussed only with regard to those grades of very low carbon or silicon content or both. As pointed out before, these are the steels that are difficult to make and Bessemer makes them satisfactorily. Considering this and also that the increase of Bessemer ore reserves has made possible an outlook for a long time ahead, the future development of the Bessemer process is of intriguing interest. What can we expect from Bessemer in its development? Along what lines will its progress take place?

Its general direction can be predicted pretty well because this starting point determines its future course. In the following discussion, some of these development factors which have now actually started into operation, will be considered.

In the acid Bessemer process the manganese, silicon and carbon and some iron of the molten metal in the converter are oxidized by blowing air through the charge. The removal of the manganese, silicon and carbon is not in any haphazard way but it follows a perfectly definite law. The rate of removal of these elements by oxidation depends on the relative amount of each one present in the molten bath and also it depends on the temperature of the bath, at any particular instant during the blow. The oxygen of the blast may combine with manganese, silicon and carbon directly but, since iron is present in very large amount proportional to the other elements and since the iron oxidizes too, the iron oxide may oxidize indirectly the silicon and carbon. When this is done, the iron oxide is in turn reduced.

In the usual American Bessemer blow the silicon and manganese are oxidized in the early part of the blow while the temperature rises rapidly due to the large amount of heat furnished by the oxidation of the silicon and also due to the fact that the products of this reaction remain in the bath and communicate their heat to it. When the silicon and manganese are nearly eliminated, the carbon begins to burn actively and the blow is finished with the bath containing metallic iron carrying a small amount of iron oxide while the silicon and manganese oxide, together with some iron oxide, form a slag.

This usual blow can be quite radically changed however. If mixer metal of high silicon content is furnished the converter, the blow will become hot due to the large amount of heat developed in burning out this silicon. If the initial temperature of the converter metal is high, then even a comparatively low silicon content in the metal will give a high temperature at the end of the blow.

The importance of the converter temperature is this: in the usual blow, at the lower temperature, the silicon and manganese are eliminated before the carbon. If the temperature becomes high, then the affinity of carbon for oxygen increases, it becomes greater than the affinity of oxygen for silicon and manganese so that the carbon combines with the oxygen. This carbon may be entirely eliminated from the bath when the temperature is high but...
December, 1931

Blast Furnace−Steel Plant

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silicon and manganese may remain therein. Such silicon and manganese remaining is called “residual” silicon or manganese.

All of this has a perfectly definite meaning with respect to the quality of metal that may be produced by the Bessemer process.

When we carry out the Bessemer process in the usual way, if we turn the converter down when full blown, we have iron, carrying some iron oxide, in the bath. Oxygen in steel is probably the most objectional element which may be present in it, so a “deoxidizer” or “softener” which is a high manganese alloy containing both silicon and carbon, is added to the bath as the blown converter metal is poured into the ladle.

This deoxidizer or softener is added in lumps of a maximum size of 1½ or 2 in. diameter and it melts and mixes with the blown metal, reacts with it and combining with the oxygen removes it as manganese oxide or as silica. Not knowing exactly how much oxygen is present in the molten bath before adding a deoxidizer, an excess is added so that after the deoxidizing action has come to an end, the metal in the ladle contains iron, a very small amount of iron oxide, and some manganese and some silicon and, of course, the carbon which it may have gained from the deoxidizer.

Compare this usual Bessemer blow with the blow carried out with a higher initial temperature at the converter. In such a case, the temperature of the metal would rise rapidly at the beginning of the blow, and before the silicon and manganese were burned out, the carbon would begin to oxidize.

It would not be a difficult matter to make up standard blowing logs for different analyses and temperatures of mixer metal and by reference to such a standard log and by making a correction for the condition of the air, a graph would give the standard initial temperature in the converter to produce a definite residual silicon and manganese content. A second graph would give the addition of cold steel or cold iron or a mixture of them to obtain this standard initial temperature. Then operating on a standard blowing cycle, when the charge was full blown and the vessel turned down, the metal would contain iron, a small amount of iron oxide, manganese and silicon.

Instead, however, of the manganese and silicon being added to the bath in lumps, as in the usual blow, the silicon and manganese are uniformly distributed throughout the bath from the beginning and they have been reacting on the iron oxide during all the blow, so that when full blown the charge has less iron oxide in it than has the usual full blown charge. Since the silicon and manganese are uniformly disseminated throughout the metal, the deoxidation is very rapid and at the turn down, the bath is practically deoxidized completely when it is poured into the ladle. This deoxidation is much more thorough, complete and uniform than it possibly can be in the usual blow or with steel made in any other way.

Now, of course, steel has been made in this way before. It is the way in which Bessemer steel has always been made in Sweden where some of the finest steel in the world has been made.

The essential difference between what I have called the usual method and that proposed here is the way the deoxidizer is obtained at the end of the blow and this is also the reason why I believe better steel for certain purposes can be made by the Bessemer process than can be made in any other way. Of course, too, you must know how to do it, but then that knowledge is required in the production of any quality product.

It may be asked, that if it be desirable that manganese or silicon be present at the end of the blow, why not add them to the bath and get them in that way?

It will not be possible to do this, because if the temperature is not right at the time the manganese-silicon addition is made, the whole order of reaction in the metal bath will be disarranged and it might
be that the addition would immediately burn out; in any event, suppose the temperature were exactly right at the time the addition was made (a practically impossible condition) the lump addition would have to be dissolved and then be mixed and distributed throughout the bath. This can never be accomplished so successfully as when the manganese and silicon are uniformly distributed throughout the bath in the beginning and kept uniformly distributed throughout the bath till the conclusion of the blow. With the control of temperature and rate of oxidation which the Bessemer converter affords to a greater extent and to a higher degree than is possible by any other steel making process of today, the steel made in the Bessemer converter in the future is going to be of finer quality and more uniformly and continuously of finer quality than any tonnage steel that has ever been made.

The Bessemer process in the future will be carried out in larger converters than those we now employ. At Hoehs in Germany they have recently started using a 45-ton converter. There is one thing though that this increase in size does not mean and that is an increase in blowing pressures. I have already called attention to the fact that high air pressure does not mean high tonnage production, and that a reduction in pressure may cause a very considerable decrease in blowing time and a decrease in blowing energy. Table B is reproduced from the article to which reference is made.

Table B—Results Obtained by Increasing Number of Tuyeres and Decreasing Blast Pressure

<table>
<thead>
<tr>
<th>Number of tuyere blocks, each containing 12 5/8-in. tuyeres</th>
<th>Old-style bottom</th>
<th>New-style bottom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of mixer metal, lbs.</td>
<td>47,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Blast pressure at engine, lbs./sq. in.</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>Total engine revolutions per blow</td>
<td>589</td>
<td>443</td>
</tr>
<tr>
<td>Time of blow, minutes</td>
<td>14</td>
<td>10 1/2</td>
</tr>
<tr>
<td>Comparison of time, per cent</td>
<td>100</td>
<td>69</td>
</tr>
<tr>
<td>Comparison of power, per cent</td>
<td>100</td>
<td>60</td>
</tr>
</tbody>
</table>

As to the question of bottom refractories. Immediately after the first few minutes of a Bessemer blow, the metal bath contains iron oxide. Those parts of the converter contacting with the metal bath obviously should be of the same chemical nature as the material in the vessel contacting with them, they should therefore be basic.

The metal bath in a basic converter is essentially of the same chemical nature as is the bath in an acid converter and in basic converters with basic bottoms a bottom life of 80 to 120 blows is obtained. Of course the slags produced in the two cases are different.

If standardized blows are to be employed, then the bottom life becomes of increased importance for, if bottom changes can be decreased in number, then the irregularity of new and cold bottoms will be reduced and a greater uniformity of product will be possible.

Similarly the body linings of converters should be of the same character as the material of the charge contacting with the body lining. An acid process converter producing an acid slag should have, as it does, an acid body lining; a basic process converter producing a basic slag should have, as it does, a basic body lining and a converter making a slag high in chromic oxide, should have a chromite body lining.

Blowing converter charges at too high pressure has possibly another effect which is perhaps more obscure but not less important in its effects. Experiments were made in our laboratory using a large glass bottle for a converter model, with a bottom which was replaceable to vary the number and size of the air openings and to change also the plan or spacing of the air openings with respect to the bottom area.

We blew this model converter with a mixture of water and oil in it to represent the metal and slag. We found that we could blow at moderate pressures without changing appreciably the amount of emulsification of the oil in the water. The relative emulsification was determined by the rate at which the mixture settled and the sharpness of separation on settling, when we poured into our ladle, a graduated cylinder.

If we exceeded moderate blowing pressures, we found that emulsification increased as a function of the blowing pressure increase and it appeared also that the design or pattern of the air holes on the bottom has some effect too on the rate of emulsification. Some patterns seem to produce a regularity of circulation in the bath that is conducive to greater rapidity of separation of the oil and water, while other patterns seem to increase the turbulence and increase the emulsification. These tests are, of course, only qualitative and it is not supposed that they represent accurately the conditions in a Bessemer converter. However it is believed that the results obtained with them are suggestive and may offer a lead for future development because, if a converter bottom design can be obtained that will facilitate the coagulation and separation of the slag particles, a step forward toward securing cleaner steel will result.

The Bessemer converter in the future will, it seems to me, be operated on a predetermined cycle, with adjusted composition and initial temperature. The volume and pressure of the air blast will be maintained or varied as the blowing cycle chart indicates, the regulation being done by automatic control. The turn down will be done automatically either when the required air volume has been blown into the converter or by the carbon-flame drop, or one method may be used to check the other.

4Iron Age (1919), vol. 103, p. 626.
The blown metal on the turn down will then be at the proper temperature and it will contain the desired amount of silicon and manganese to secure the proper softening reaction which will be completed during pouring.

For other than soft steel blows, the turn down will be made automatically when the predetermined volume of air has been blown to obtain the specified carbon. The bath will contain requisite silicon and manganese which, being residual, will rapidly deoxidize the metal so that, on pouring, no additions need be made for this purpose.

Every one of the elements or factors entering into what I have called the Bessemer practice of the future is now employed in some plant, except the automatic control of volumes and turn down, and these two things are the most easily executed of any of the proposals.

The writer confidently believes the Bessemer process to be a superior steel making process for tonnage steel. The exactness of the control which is now possible, guided by the technical intelligence that the process deserves is going to make the American Bessemer process one of continued and increasing importance.

Slab Mill Driven by Three Reversing Motors

(Continued from page 1561)

series fields permits such unbalance of speeds, but with the same shunt excitation, it results in an unbalance in load on the two motors. To overcome this difficulty and permit balanced loads with rolls of unequal diameters there is provided a differential rheostat in the shunt field circuit by which the shunt excitation may be slightly unbalanced. The effect is to give each motor the proper total excitation to produce the required unequal speeds with equal loads.

Securing Proper Speeds

A further problem is to secure the proper relative speeds of the 10,000 hp. horizontal roll drive and the 2,500 hp. vertical edging roll motor. The ratio of horizontal and vertical roll motor speeds depends upon the ratio of roll diameters, per cent reduction in each stand, and the direction of operation. On the odd numbered passes the steel passes from the horizontal to the vertical rolls, and the entering speed of the vertical mill must equal the delivery speed of the horizontal mill, and if a reduction is made by the vertical rolls, their peripheral speed must be higher than that of the horizontal rolls. On the even numbered passes the peripheral speed of the horizontal rolls must be greater than that of the vertical rolls, owing to the reduction in the horizontal mill. The following tabulation shows the speed relations for a number of different conditions.

<table>
<thead>
<tr>
<th>Pass</th>
<th>Roll Diam. Hor.</th>
<th>Per cent Reduction Hor. Vert.</th>
<th>Roll R.P.M. Hor.</th>
<th>Vertical motor r.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odd</td>
<td>44 26</td>
<td>5</td>
<td>40</td>
<td>67.7</td>
</tr>
<tr>
<td>Odd</td>
<td>44 26</td>
<td>5</td>
<td>40</td>
<td>71.3</td>
</tr>
<tr>
<td>Odd</td>
<td>45 25</td>
<td>5</td>
<td>40</td>
<td>75.8</td>
</tr>
<tr>
<td>Odd</td>
<td>43 27</td>
<td>5</td>
<td>40</td>
<td>63.7</td>
</tr>
<tr>
<td>Even</td>
<td>44 26</td>
<td>5</td>
<td>40</td>
<td>67.7</td>
</tr>
<tr>
<td>Even</td>
<td>44 26</td>
<td>5</td>
<td>40</td>
<td>64.3</td>
</tr>
<tr>
<td>Even</td>
<td>44 26</td>
<td>5</td>
<td>40</td>
<td>54.1</td>
</tr>
<tr>
<td>Even</td>
<td>45 25</td>
<td>5</td>
<td>40</td>
<td>68.5</td>
</tr>
<tr>
<td>Even</td>
<td>43 27</td>
<td>5</td>
<td>40</td>
<td>51.0</td>
</tr>
</tbody>
</table>

With the horizontal roll motors running at their base speed of 40 r.p.m., the vertical roll motor must operate at some speed between 96 and 114 r.p.m. during the odd numbered passes, and between 76 and 102 r.p.m. during the even numbered passes. To provide these ranges of speeds there are provided two rheostats in the vertical roll motor main shunt field circuit. A double throw contactor is arranged so that during the odd numbered passes one rheostat is shortcircuited and made inactive. The other rheostat has a permanent resistor section to provide a minimum full field speed of about 95 r.p.m. and an adjustable section to give the necessary speed range from 95 to about 115 r.p.m. During the even numbered passes, the double throw contactor short circuits the above described rheostat, and makes the first rheostat operative. This rheostat provides a full field speed range of about 76 to 102 r.p.m. Thus the two rheostats may be adjusted to provide the desired base speeds of the vertical roll motor for the odd and even numbered passes, respectively, to suit the relative roll diameters and average reductions per pass. Theoretically the base speed should be different for each different reduction, requiring individual rheostat settings for each pass. However the 2,500 hp. vertical roll motor has a comparatively heavy variable potential series field winding and hence has a drooping speed-load characteristic. In practice it has been found that this drooping characteristic is sufficient to provide satisfactory load division with the adjusting rheostats set for the average conditions.

The complete drive, consisting of the three reversing motors, is operated and controlled with the same facility as the usual blooming mill with only a single motor drive. The roller controls the direction and speed of the three main roll motors with a six-point foot-operated master switch, and controls the front and back main tables and the horizontal and vertical roll screwdowns with hand master switches. A second pulpit operator controls the ingot transfer car, first and second approach tables, side guards and manipulator.

This installation represents the greatest power and torque yet applied to a reversing mill, the flywheel motor generator set is the largest in steel mill service, and the method of drive using three reversing motors is a distinct advance over previously used methods. In the few months since operation started, the equipment has demonstrated its ability to perform satisfactorily in this extremely heavy reversing slabbing mill service.
Bottom-Cast Practice

A thorough discussion of the subject, including comparisons between various equipment and methods commonly used

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The history and experiences of technology may be likened to those of human affairs in that they are often repeated. Many old processes and methods that at one time were believed to have lagged behind in the procession of progress have been found to fill certain requirements in present day industry with remarkable success. Thus, the Bessemer process, at one time the means of revolutionizing the production of railroad rails, could not keep pace with subsequent demands for a still better steel and was gradually replaced by the open-hearth process which removed the phosphorus from the pig iron, an impossibility for the acid converter process.

Although the tonnage of Bessemer steel will never again attain the proportions in which it was once produced, in recent years a marked increase in production has come about owing to the fact that Bessemer steel is more economical and in some instances superior to open-hearth steel for certain purposes. In addition to new uses for Bessemer steel, the recent development in the manufacture of mechanically puddled iron is an excellent example of how an old, seemingly worn out process may suddenly be found adapted to fill a new need.

The same changes are noted in methods and practices of handling steel and converting it to ingot form. Pouring practices have been subject to radical changes in the past few years. Bottom casting is an old practice that was employed in the earlier years of the industry before mechanical handling equipment was perfected as it is now; and in addition, this method of casting had certain inherent advantages over top-pouring. However, with the gradual increase of tonnage requirements and fostered by improvements in handling equipment, top-pouring became the prevailing practice. The purpose of this article is to discuss general considerations of bottom-cast practice with particular regard to design, pouring practice, and quality of the ingots.

Bottom-cast ingots are made, as the term implies, by filling the molds from the bottom instead of the usual practice of pouring through the top. There are other fundamental differences between this method of casting and the more ordinary practice of top pouring. Bottom-cast ingots are usually smaller than the top-poured variety, and while the latter are almost invariably cast singly, a large number of ingots may be bottom cast simultaneously. From an economic point of view bottom-cast practice is at a disadvantage when compared to top-pour practice except under special conditions to be discussed later. The quality of bottom-cast ingots is generally supposed to be superior to any other type of ingot, although this is not necessarily true.

Fig. 1—A typical bottom-casting arrangement which illustrates the use of male and female runner-brick
Owing to the fact that the steel enters through the bottom of the molds the initial splashing incident to top pouring is avoided, and as a rule bottom cast ingots are free from surface defects which arise from this cause. This was at one time considered a paramount advantage of bottom-casting but with present day tonnage requirements and improvements in top-pour practice it is a minor consideration. Bottom casting is now employed for one of two reasons: either the plant in question is not equipped with a blooming mill for breaking down large ingots, and large heats of steel must be cast into small ingots to meet the requirements of a small roughing mill; or ingots of this type are required for a special purpose. Bottom-casting is an excellent method for producing ingots which weigh from 1000 lb. to 3000 lb.

Top-pouring has many advantages over bottom-casting. The ingots are much larger and with the proper equipment they may be delivered quickly to the rolling mill and charged into soaking pits with a large proportion of the initial heat content remaining in the steel. This constitutes a saving on heating fuel, and the performance cannot be duplicated with bottom-cast ingots. These ingots must be allowed to solidify before they are handled and the work of removing them from the casting pit is relatively slow, all of which operates against speedy delivery of the steel to the rolling mills.

Bottom-casting is in great favor in English and Continental practice but it is not used in this country except under the special conditions which have been mentioned. One outlet for bottom-cast ingots is found in the Pilger process for the production of seamless tubing. This process requires round ingots of varying heights and diameters, depending upon the length and size of tubing to be made. A length of pipe is made from each ingot and bottom-cast ingots have been found to be the most economical form of steel. Whether or not it is possible to roll large rounds economically for this purpose is open to investigation.

Method of Casting

In order to admit steel through the bottom of a mold a special arrangement is necessary, a representative diagram of which is shown in Fig. 1. The steel is poured into a central runner or fountain which is connected at its base with a system of runner brick that distributes the steel to the molds. The molds are arranged in a group about the fountain and a runner brick under each mold has an outlet on its upper face through which the steel enters the mold. The runner brick are laid in a cast iron plate or “stool” which is cast with grooves in it, according to some predetermined design. After a heat of steel is poured into a number of stools or “set-ups” the metal which remains in the runner brick must be removed and fresh brick laid in place for the next heat. This steel or “sprue” which remains in the brick constitutes an unavoidable production of scrap and this together with the cost of fresh brick for each stool increases the cost of the ingots. Other reasons why bottom-cast ingots are more expensive than the other variety are that labor costs are higher and mold life is shorter.

The equipment necessary for bottom casting, exclusive of the usual pouring equipment, consists of stools, fountains, runner brick, and molds. Special stripping cranes are necessary also, because ordinary ladle cranes are too slow for this purpose. It is likewise essential to have an extra set of stools for each set-up so that when the ingots are stripped the molds can be placed on stools that have been prepared for casting.

The amount of labor that is required depends upon the general efficiency of the layout. In this connection it may be said that the more room allowed for operations the better, because a large proportion of the work must be done while hot steel is in the casting pit, and working conditions in the average bottom-cast shop are never to be envied.

The preparation of the casting stools is one of the most important steps in the production of the ingots. The runner brick must be placed so that steel cannot leak through the joints, and the top surface of the brick must be flush with the stool to insure perfect contact of the molds and stool at all points. The majority of breakouts occur from steel running from the base of the molds. The central fountain is placed on the stool after the runner brick are laid. The fountain consists of two castings which are keyed together and is lined with special brick. This lining must consist of two castings which are tied together and is lined with special brick. This lining must be renewed after each heat. The bottom of the fountain rests on a

![Fig. 2—Rectangular bottom-cast stool](image-url)
Stool Design

The design of stools is a task that requires considerable judgment, and the success or failure of the practice usually lies in this feature. The factors to be considered in the design are:

1. Available floor space
2. Tonnage of steel per heat
3. Sizes of molds to be used
4. Cost of runner brick
5. Ease of cleaning the set-up after brick are laid.

Floor space is an important consideration and it may be stated at the outset that the area cannot be too large. Aside from personal discomfort to workmen nothing can so impede the proper design of stools as being forced to crowd the arrangement. It should be the aim of the designer to make the stools as large as will be consistent with the size of the heat and the pouring facilities. It is also most economical to cast as many ingots per group as possible. The tonnage of steel per heat is related intimately with the size of the groups and quality of the product. It is poor practice to cast large heats into small groups of ingots because pouring difficulties and defective ingots will result.

If a variety of mold sizes is to be used, the stools must of course be designed to accommodate the largest size. In some types of stools it is possible to reduce the number of molds when changing to a larger size. This is good practice if the weight of ingots per group is not decreased in so doing. The pouring speed is necessarily a function of the weight of ingots per group, and it is not advisable to increase the pouring rate unless it is absolutely necessary.

In many instances, a proper design of the stools will mean a saving in the cost of runner brick. The more simple the arrangement can be made the better, because this means that a minimum of special shapes must be kept in stock. In general, this will reduce the refractory cost.

The final consideration, and one that is most important, is the matter of designing the stool so that it will be possible to clean the set-up of foreign material such as chips of brick, sand, and clay. This material is certain to get into the runner brick during the work of preparing the stools, and it is advantageous to be able to clean each row of runner brick with a blast of air as the final step in preparation, before the molds are spotted on the stools. Dirt is the greatest enemy of quality steel and provisions must be made for fighting it at every step in the process.

In the accompanying sketches are shown three representative types of stools for bottom casting ingots. Fig. 2 shows a common design. It is limited as to the number of molds that can be placed upon it which is an objection unless small heats of from 40 to 50 tons are to be poured. One mill which employs this type of stool makes heats of about 50 tons and pours the steel into three or four groups, depending upon the ingot size ordered. The principal objection to this type of stool is that if the molds at the extreme ends are too far from the fountain the temperature of the metal drops too much by the time it is delivered to these molds, and ingots of uneven height are apt to be produced. The stool is advantageous for the size of heats mentioned because it is simple in design and is amendable to cleaning after the runner bricks are placed.

Fig. 3 is an unusual design. The aim in this instance was to eliminate the objection of unequal length of ingots, which was outlined in discussing the previous design. In this one particular the design was successful, but the gain in this direction is offset by several disadvantages.

It is impossible to clean the brick after they are in place, and a large number of individual brick shapes are required to make up the plate. It is also necessary to place weights at the points indicated to keep the distributing spider brick in place. The force exerted by the molten metal as it rises from the lower course of brick is considerable, and these four points are a source of break-outs. The weights must be heavy enough to resist the force of the steel against the spider and they must be properly balanced on the brick. The design is not fool-proof as the record of breakouts on this type of stool shows.

The weaknesses of the design of this type of stool were emphasized by the pouring practice employed. The stool as sketched accommodates 16 molds and it was the practice to cast heats of 125 tons into from six to eight groups. The ladle pressure from a heat of this size is very great and breakouts under the...
weights on the brick was one of the difficulties encountered. Moreover, the casting temperatures were necessarily high and a large proportion of cracked ingots were made. It will be shown later that there is a definite relation between the casting temperature, pouring speed, and size of groups that bears on the production of cracked ingots. Groups of this size are too small for heats of 125 tons and more. Some of the objections to this stool might be remedied by designing it to accommodate twice as many molds. The consideration of floor space enters at this point: in order to pour twice as many ingots per group, the area required would have been over two and one-half times as great as the original area. Shop conditions would not permit of a change to a larger stool because of limited floor space.

In Fig. 4 is sketched a stool that combines the good features of the preceding designs, and has the added advantage of being flexible with respect to the number of molds that can be placed upon it. The ratio of area to tonnage of ingots is greater than in the preceding designs, but this objection is negligible in view of the advantages of the arrangement. As many as 48 ingots have been cast on a stool of this type in the regular practice of the shop.

**Runner Brick**

Runner brick for the stools are made of fire clay. They should introduce a minimum of non-metallic matter into the steel and to meet this requirement an attempt should be made to select a hard, dense brick with as high a melting point as is consistent with these qualities. The melting point of the material may be disregarded to some extent. It is inevitable that some of the brick will be eroded by the force of the stream and by chemical action; therefore, if the brick will not chip or break in handling, or spill from the intense heat of the steel there is little danger of contaminating the metal. Such refractories and loose material in the runners as will fuse has an excellent chance of rising to the surface of the metal in the molds. Most of the slag that is seen floating on the surface of the steel as it rises in the molds is refractory material that has been fluxed and melted away from the runner brick. On the other hand, loose chips of refractory material that may remain in the runners after making up the stool do not fuse readily, for obvious reasons. The temperature of the initial metal to enter the runner brick is much reduced owing to the chilling effect of the relatively cold brick, and although this metal will carry much of the loose refractory material along with it, the probability is that the material will be trapped in the lower portion of the ingot and can be later identified on the cold ingots. This is particularly true of heats that have been cast on the cold side. The ingots from such heats will have a very dirty surface if the runner bricks contain loose refractory material. This is a good reason for specifying bricks that will not deteriorate physically, and for a stool designed so that it will permit of blowing dirt and loose mate-

![Fig. 4—Octagon bottom-cast stool](image-url)
form expansion. The conditions met in bottom-casting are entirely different because here the lower part of the mold is heated to a higher temperature than the upper part. This is evident when it is considered that the metal in the upper portion of the rising steel has been cooled by contact with the cold runner bricks and molds and is nearer the freezing point than the fresh, hot metal that is entering continuously at the base of the molds. The resultant uneven expansion of the mold metal tends to enlarge on any defects the casting may have, and in time fire cracks and similar defects are produced. *

Another incident that shortens the life of bottom-cast molds is to place them off-center with respect to the outlet in the runner brick. This not only heats one side of the mold unduly, but the inner wall is apt to be cut away if it is too near the entering stream of steel.

The size and shape of cross-section of the molds used in bottom-cast work are determined in almost every case by the requirements of the process for which the ingots are intended. This is not always conducive to the production of high quality ingots, but it is usually an unavoidable condition. An ingot whose ratio of surface area to weight is high is more likely to be free from longitudinal cracks than one whose corresponding ratio is lower. After a mold is filled with steel there is a short period during which the steel and the mold are in actual contact. At this time heat is conducted away from the ingot rapidly and the heat transfer from ingot to mold is proportional to the area of the surfaces in contact. When the ingot cools it shrinks away from the mold and contraction stresses are induced which must be resisted by the "skin" of solidified metal at the surface of the ingot. The "skin" or shell of solid steel develops during the time in which the mold and ingot are in actual contact, and therefore in order to develop a skin that is strong enough to resist contraction stresses, as large a surface area as possible should be provided.

An ingot with a circular cross-section will have the least area in contact with the mold wall of any possible design. A round ingot, 12 in. in diameter and 60 in. high, will weigh about 2,000 lb, if the steel is dead killed. The surface in contact with the mold wall is about 2500 sq. in. An ingot weighing the same amount and of the same height, but with a square cross-section has a corresponding surface area of about 2,800 sq. in. The ratios of area to weight are 1.25 and 1.40 respectively. From this it would be expected that the round ingot would be more susceptible to longitudinal cracks than the square ingot and such is actually the case.

Unfortunately, in this regard, round ingots are often required of the steel plant department. Ingots for seamless tubes which are made by the Pilger process must be round because of the manner in which the tube is formed. The ingot is first pierced and then forged out over a mandrel in the Pilger mill to form a seamless tube. The first mechanical operation, that of piercing, requires a round ingot.

An interesting evolution in mold design is noted in the case of a Western steel plant where all steel for the rolling mills is bottom-cast. At the start of operations, when tonnage requirements were low, a square ingot 9 in. x 9 in. in section was made. Later, a 12 in. x 12 in. ingot was ordered on account of increasing tonnage requirements at the rolling mill. Some trouble was encountered in obtaining a uniform rolling temperature with the larger size, owing to the design of the reheating furnace. The steel in this plant was all reheated because of the absence of soaking pits, and the ingots were pushed through an oil-fired furnace on water-cooled skid pipes. In the travel through the furnace two faces of each ingot were in contact with the ingot before and behind. Therefore these two faces were heated largely by conduction and the remaining two faces were heated by the hot furnace gases; this condition resulted in uneven ingot temperatures.

When tonnage requirements again increased, it was feared that an ingot larger than 12 in. x 12 in. would be impossible to heat properly, therefore a round section was substituted for the square one. This solved the problem of getting a uniform rolling temperature because only a very small area of the ingots was in contact in their travel through the furnace.

From what has been said previously, one would expect that the open-hearth department would have suffered from an epidemic of cracked ingots when the change to a round cross-section was made, but such was not the case. In this shop it was the practice to cast an entire heat of about 75 tons into two groups of bottom-cast molds. The temperature distribution of the steel in the molds under these conditions was such that no ill effects were experienced in so far as sound ingots were concerned. As will be explained later, high temperatures such as are necessary in bottom casting steel tend to produce longitudinal cracks in round ingots if the steel is teemed too rapidly. The teeming of over 35 tons of steel required about 10 minutes with the existing practice, and this may be compared to data given later in the article, that were obtained from a practice which resulted in a considerable proportion of cracked ingots. Although round molds were used in both cases, the difference in pouring practices resulted in products of different qualities.

**Ingot Defects**

There are two classes of ingot defects; those which are inherent and unavoidable, owing to the properties of molten steel, and those which are the result of faulty practice. In the first class the most outstanding defects are piping and segregation. The second class, and those peculiar to bottom-cast ingots, include cracks, surface overlaps, blowholes internal and external, silica inclusions, and shrinkage cavities on the bases of the ingots. All the aforementioned defects are common to all types of in-

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(Continued on page 1587)
Iron skulls and iron scrap are produced at the ingoing and outgoing ends of the metal mixer, and transfer ladles from mixer, or mixer ladle, to the open-hearth furnaces. By far the largest portion of scrap so produced will be found in the production of iron skulls, an item largely dependent on the temperature of the iron used, the distance from the metal mixer to the furnaces, and the number of transfer ladles required per charge. The type of hot metal and mixer will largely govern the temperature of the hot metal sent to the open-hearth furnaces, eliminating from this consideration the effect of intermittent operations or abnormal operating conditions. In recent years the use of the closed top ladles, or mixer ladles, between blast furnaces and open-hearth plant or mixer, has perceptibly reduced the amount of iron scrap produced in handling hot metal between blast furnaces and open-hearth and since the iron has been maintained physically hotter throughout the entire cycle it has also contributed to a reduction in the amount of skulls produced between metal mixers and open-hearth furnaces. Plants requiring several ladles of hot metal to make up the necessary charge will show a greater percentage of iron scrap produced, all other conditions being equal.

As a rule, the production of .50 per cent of iron scrap and skulls per ton of hot metal is sufficiently high to take care of differences in pig iron analysis, temperatures, and variable conditions of handling at different plants. The following figures indicate the production of iron scrap, including iron skulls, at various open-hearth plants over a period of two years. It will be noted that Plant No. 8 shows a production of 1.20 per cent iron scrap per ton of hot metal which is equivalent to .62 per cent per ton of ingots. This plant has been taken as a basis for calculating the possible economies in reduction of this item, assuming the high production of scrap to be reduced.

Table VII—Per Cent of Iron Scrap and Skulls Produced Per Ton of Iron

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>Period 1</th>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.66</td>
<td>.46</td>
</tr>
<tr>
<td>2</td>
<td>.42</td>
<td>.38</td>
</tr>
<tr>
<td>3</td>
<td>.36</td>
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<td>7</td>
<td>.61</td>
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</tr>
<tr>
<td>8</td>
<td>1.20</td>
<td>1.07</td>
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</table>

Table IV shows the total scrap production per ton of metallic charge as 4.80 per cent, made up as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron skulls and iron scrap</td>
<td>.55</td>
</tr>
<tr>
<td>Pit scrap, including steel skulls</td>
<td>.24</td>
</tr>
<tr>
<td>Ingot butts and condemned ingots</td>
<td>.01</td>
</tr>
<tr>
<td>Total scrap produced</td>
<td>4.80</td>
</tr>
</tbody>
</table>

If it is assumed that the plant in question could operate with the equivalent of .50 per cent iron scrap and skulls per ton of iron, instead of the 1.20 per cent shown, then this item becomes .23 per cent scrap produced per ton of charge instead of the .55 per cent indicated, resulting in a proportionate increase in the ingot yield but qualifying for the losses incidental to the use of hot metal.

In other words, the reduction in amount of iron scrap is equivalent to a proportional increase in the amount of hot metal actually consumed and since.
as indicated in Table III, there is a loss of 10.227 per cent per unit of pig iron consumed, the loss figure would be changed from 7.21 per cent to 7.24 per cent and the yield raised from 87.77 per cent to 88.28 per cent.

It is common knowledge among open-hearth operators that an increase in the charge is not reflected by a proportionate increase in tonnage per unit of time, and that within reasonable limits about 50 per cent of the increase is gained per unit time. However, in view of the extremely small amount involved, namely, 328 tons per heat, it is assumed that the increased production would be obtained in the same time which accordingly would result in a reduction of the cost above net metal on those costs normally affected by increased tonnage. To state it another way, the cost above net metal would be increased slightly in the production of 100.328 tons as compared to the production of 100 gross tons, the largest factor being those items based on tonnage rates. The allowable difference of $0.82 for the entire heat is the equivalent of 50 per cent of the items of cost above net metal affected by tonnage increase.

In view of the influence of the cost of transporting, preparing and charging iron scrap and iron skulls, the following figures show the savings possible with various assumed costs for this item, resulting in a saving ranging from $.022 to $.038 per ton of ingots:

<table>
<thead>
<tr>
<th>Assumed cost for scrap preparation etc.</th>
<th>Final ingot cost</th>
<th>Savings per ton ingots over hypothetical standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1.00</td>
<td>$24.256</td>
<td>$.022</td>
</tr>
<tr>
<td>2.00</td>
<td>24.252</td>
<td>.026</td>
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<td>3.00</td>
<td>24.248</td>
<td>.030</td>
</tr>
<tr>
<td>4.00</td>
<td>24.244</td>
<td>.034</td>
</tr>
<tr>
<td>5.00</td>
<td>24.240</td>
<td>.038</td>
</tr>
</tbody>
</table>

**Pit Scrap, Including Steel Skulls**—At all open-hearth plants it will be found that by far the largest part of the total scrap produced in the conversion of any metallic charge into ingots, consists of pit scrap and steel skulls. As a rule, this will constitute from 50 to 75 per cent of the total. An increase in the amount of pit scrap and steel skulls is the equivalent to a direct reduction in the ingot yield and materially affects the total ingot cost. It is a source of scrap production which at least to some extent is amenable to reduction.

In the following discussion, pit scrap includes steel runner and ladle scrap, scrap produced at pouring platform due to running stoppers, splashes, etc.; steel skulls; slag thimble skulls, monkeys and scrap recovered in pit or on monkey walls; breakouts; miscellaneous spills; and also scrap recovered from open-hearth slag. The figures submitted indicate the sources and the different types of scrap involved in this item at one plant.

The production of skulls in excess of the amount incident to the production of the best quality steel is a definite monetary loss. Open-hearth operators, as a rule, prefer to refine at reasonably high temperatures, tapping at somewhat lower temperatures and pouring at temperatures which will result in a small pan-cake or skull in the bottom of the ladle. Such practice is generally conceded to give consistent satisfactory results. At times this is carried to an extreme in the belief that even lower temperatures may improve steel quality, which results in a very definite increase in the skulls produced, amounting at times to as much as 1% to 2% of the total metallic charge.

Some of the more important methods of reducing pit scrap and skull production may be listed, as follows: Maintaining tapping hole in proper condition and keeping bottom in proper condition, which includes in addition to normally careful draining of holes, the consideration of better bottom materials. Where heats are re-pigged when melting soft, or when melting high require large amounts of ore, the over-flow spouts of newly lined ladles can be bricked up to diminish the amount of pit scrap resulting from the large size heat. Other contributing factors which can be corrected are slope of the ladle to facilitate better draining, and the draining of the steel from ladle into molds, particularly where ingot butts are produced. This latter results in producing a much better class of scrap than pit scrap and eliminates the cost attending transportation, preparation, and final consumption of pit scrap.

**Condemned Ingots and Ingot Butts**—In addition to the classes of scrap produced at open-hearth departments two other types result from the production of ingots, namely, condemned ingots and ingot butts. The amount of this type of scrap is usually kept within reasonable limits and is subject to little reduction. The length of the ingot butt that can be handled by the rolling mills determines if it will be scrapped or rolled, and where plants use a variety of mold sizes, an increase in ingot butt practice in percentage of total metallic charge obtains with the larger size molds.

The amount of condemned ingots at most plants is largely dependent on the tolerance in specifications and standard of inspection for quality and pouring practice. Increasingly severe close chemical limits are usually accompanied by increased off-heats and where these heats cannot be diverted to other orders, these ingots are scrapped. As a rule, the total amount of condemned ingots and ingot butts will be approximately 1 to $\frac{1}{2}$ per cent per ton of ingots. In general, in order to maintain a uniformly low production of condemned ingots all
plants exercise great care in inspection of molds, pouring, and in the endeavor to produce steel of the required chemical specifications. The development of a rapid method of determining the iron oxide content of the final slag prior to tapping may assist in the reduction of off-heats, particularly in the lower carbon ranges.

Ingot butts and condemned ingots are naturally considered a high quality scrap and any excessive production is reflected in an increase in ingot cost, through the adverse effect on yields as well as the cost above net metal. In the foregoing examples, ingot butts and condemned ingots are considered at a hypothetical value of $19.00 per gross ton. Therefore, the production of 1 per cent ingot butts and condemned ingots is approximately equivalent to the difference between the cost of ingots and the value of scrap and the effect on cost above net metal through decreased yields. On the hypothetical comparisons of ingot costs, discussed under pit scrap and iron skulls, the production of 1 per cent ingot butts and condemned ingots is equivalent to an increased total ingot cost of approximately $.08 to $.09.

Loss

The foregoing discussion dealt with the influence of scrap production on operating economies. The following deals with the types of losses involved and the extent to which they may be reduced by utilization as scrap, etc.

Losses in open-hearth departments are made up generally, as follows:
1—Metalloids eliminated and lost in waste gases, etc.
2—Metals lost in slag.
3—Metals lost in slag pockets.
4—Metals lost as dust in checker chambers, waste gases, etc.
5—Metals lost due to unrecoverable spillage, etc.

It is assumed in any discussion of losses that the analysis of the slags as well as the slag volume are those required for the proper production of quality steel. Excessive slag volumes, due to radical changes in silicon or phosphorus content of the pig iron, are followed by increased lime charges in the open-hearth and result in excessive slag volume. All open-hearth operators are familiar with additional costs incidental to excessive slag volumes, since the time of the heats and the fuel consumption are increased and cost above net metal is adversely affected by decreased tonnage. In addition, the ingot yields are decreased due to the additional loss of metallics in the slag. In the papers referred to previously, the decided influence of variations in silicon and phosphorus in iron, as well as silica in ores, have been covered. These lowered yields result in increased cost for net metallic mixture and, therefore, a higher ingot cost. It is not the province of this paper to discuss slag analysis characteristics since they vary from plant to plant due to difference in analysis and type of materials, as well as steels produced. It is assumed that the analysis and slag volumes are those required for the type of steels produced.

Table IV shows a loss of 7.21 per cent per ton of metallics charged, which represents good practice for the plant in question. In this particular case it, therefore, becomes not a matter of reduction of these losses, but the possible conversion of some of these losses into useful commodities. At least two of these losses can be so converted, namely, open-hearth slag, and checker chamber dust.

Recovery of Open-Hearth Slag—Considerable information has been published in the Yearbooks of the American Iron and Steel Institute concerning the value of high manganese iron in open-hearth practice and it is not the intention of this discussion to repeat the well known economies due to high manganese iron, such as reduction in pig iron costs, greater fluidity of iron, frequent speeding up of heats, etc., and improvement in quality of steel, etc. The widespread use of open-hearth slag at blast furnaces, amounting in some cases to as much as 60 per cent of the total open-hearth slag produced, is a clear indication that the steel industry has recognized the economy and value of such practice.

The analysis of the iron shown in Table II indicates a high manganese iron which, in the case of the plant under discussion, was produced through the medium of open-hearth slag in combination with some manganiferous ore. The open-hearth slag consumed amounted to approximately 224 lb. per ton of iron. This, based on the open-hearth charge of hot metal and cold iron, approximates 126 lb. of open-hearth slag per ton of metallic charge. Since the plant in question produced 302 lb. of slag per ton of charge, about 42 per cent of the slag was consumed at the blast furnaces and a credit should be obtained on the equivalent amount of metallics contained in the slag.

The use of open-hearth slag at blast furnaces has resulted in decreased costs of pig iron, not only through the modest arbitrary value placed on open-hearth slag to encourage its use, but also to actual economies in the reduction in limestone, coke, etc. Naturally, this decreased pig iron cost is reflected in the total ingot cost. Further savings are claimed by open-hearth operators, such as the reduction in limestone, in time of heats, and usually a saving in manganese.

The following data clearly indicate the results obtained at one plant over a period of three years, operating with increasingly higher manganese through increased amounts of open-hearth slag at the blast furnaces, and it will be noted that in Period 3 the residual manganese is lower than Period 2, in spite of a perceptible increase in the manganese content of the pig iron. This is due not only to a slight increase in the volume of run-off slag, but a material increase in the manganese content of same, namely, from 9.16 per cent Mn in run-off slag in Period 2, as against 13.17 per cent Mn in Period 3.
there is a possible loss of .375 per cent per ton of charge. If 50 per cent of the open-hearth slag is recovered at blast furnaces there remains a net loss of approximately .187 per cent per ton of charge. This figure naturally varies with the practice of the respective plants, the method of slag handling and disposition of the slag. Based on the ingot cost of approximately $25.00 previously used, this loss is equal to approximately $.050 per ton of ingots.

Iron Lost in Checker Chamber Dust—The amount of checker chamber dust is largely a function of the per cent of iron charged, type and percentage of scrap, type of fuel used, draft conditions of the furnace and method of operation.

Apparently the most important factor is the type of fuel used as the following table clearly indicates. Table IX shows the analyses and amounts of checker chamber dust produced per ton of ingots for a variety of conditions.

### A Letter from Germany on the Dry Cooling of Coke

I had an opportunity to inspect a Sulzer dry coke cooling plant at the Witkowitz steel works in Czechoslovakia. Not considering the fact that this plant is of older design, it works with indisputable success. With one ton of dry cooled coke 400 kg. of steam are produced at pressures up to 14 atmospheres. One of the blast furnaces of the Witkowitz works is operated exclusively with dry quenched coke, whereby a fuel saving of 3 per cent is effected. The blast furnace operators assured me of this fact and I found it confirmed in the daily records of operation.

“The first plants at Magnitogorsk and Kuznezk will use the wet quenching process. Now it will be necessary to make provisions for a change to dry quenching for the extension plants and to build the coke ovens with a view of adopting the dry quenching process.

“Considering the tremendous scale of the plants at Magnitogorsk and Kuznezk the economies effected by dry quenching are bound to be tremendous.”

Member of the Commission of the Wostokostal in Germany,

Signed: Schadrin, Berlin.
The monthly boiler report, giving a concise review of the operations of the various boiler plants, obtains its basic data from the specialized reports made up for cost purposes. These reports, several of which have been exemplified, summarize the major items involved, such as fuel consumed, in terms of equivalent coal; and the water delivered to each plant, converted to net pounds of steam evaporated from and at 212 deg. F.

The operating data, comprising the average number of boilers in use; steam conditions—pressure, superheat, and feed water temperature; and the total number of boilers installed with their rated capacities; are taken from the daily log sheets filled in by the boiler foremen. These daily figures, averaged from the designated sheets or charts, are recorded in a book designed for this transfer, and the totals or averages for the month just closed are abstracted for the monthly report.

While the resulting efficiency and economy figures may not be thermally accurate, such as would be punctiliously determined in boiler tests, they serve as excellent comparative summaries; and present the results obtained on a uniform basis, permitting an analysis of the boiler operations for each month and comparisons with other like periods. The report gives the management a clear view of the effectiveness of the various boiler plants.

As made up for the plant under discussion, this report may vary somewhat from similar statistics from other establishments. Each factory develops its own bases of judgment and operation analysis as best suits its own requirements. The essence of such reports, however, is very much alike. Undoubtedly simplicity and brevity, with the inclusion of only the meat of the operations, are desirable virtues in the design of statistics that are to be
scanned by executives. Cost data that are dissected by trained accountants may be more elaborate and detailed. They obtain actual coal unloadings, blast-furnace gas credits, other fuel weights or volumes in their original form for direct application of prices and invoices accurately determined. At the same time they segregate labor charges, apply general plant overhead that includes pro-rated cost of management, accounting, laboratory and other charges entirely outside the boiler room; as well as the usual fixed charges of taxes, interest, depreciation and renewal funds, where such costs are carried departmentally in monthly or periodic reports. These items do not affect the work of the steam engineer except where he may be designated to assist in the reduction of such costs. Usually the data procured and presented in monthly report form become but a part of the data utilized by the cost department in their final accounting. Only a portion of such a comprehensive cost distribution statistics—that which applies to the steam department solely—gets back to the steam engineer or boiler superintendent for their study.

The monthly boiler report for our plant is illustrated as Table I. This report covers the factors that interest the management; such as output, load factor, fuel distribution with reference to each type of fuel used at each boiler house, boiler economy, and a few other items that have been condensed into a simplified abstract form.

While this report is readily understood by the average engineer, it might be well to briefly enumerate the derivation of these figures. The various items will be defined as numbered in the report:

1.—Total Evaporation: Obtained from the boiler feed pump calculations based upon strokes, slippage corrections, and so forth. This includes water delivered from boiler water pumps, return steam condensate; but not boiler blow-downs, or boiler water losses, which are subtracted. This figure checks the total shown on the steam distribution report—including the boiler auxiliaries and unaccounted for steam, all of which are evaporated by the boilers.

2, 3 and 4—These steam conditions of pressure, superheat, and feed water temperature, are average records for the month, taken from daily instrument charts.

5.—Factor of Evaporation: Derived by the formula

\[
F. \text{ of E.} = \frac{\text{Total Heat in Steam} - (\text{Feed Temp.} - 32)}{970.4}
\]

Steam data is taken from items 2, 3 and 4. The actual pounds of water delivered to the boilers multiplied by this factor of evaporation gives the value of Item 1. This factor is

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Curve Sheet No. II—Conversion of units of economy, items Nos. 20 and 21, pounds coal per boiler horsepower to pounds water evaporated per pound fuel, and vice versa.
also used in determining equivalent evaporation figures of the steam distribution report.

6—Total b.hp. hours is equal to Item No. 1 divided by 34.5 (lb. water per b.hp. from and at 212 deg. F.).

7—Average b.hp. hours per hour: Item No. 6 divided by the number of hours in the month. Often designated as "Boiler Horsepower Months."

8—This figure includes all the boilers comprising the boiler house.

9—Size or rating of each boiler.

10—Total boiler capacity: Item No. 8 X Item No. 9.

11—Actual number of boilers operated the equivalent 24 hours per day throughout the month. Taken from log sheets of boiler plants.

12—Item No. 11 multiplied by Item No. 9.

13—Rating developed by boiler used: Item No. 7 divided by Item No. 12.

14—Per cent of installed capacity: Item No. 7 divided by Item No. 10.

15, 16, 17, 18 and 19—Total fuel, in terms of coal, charged to each boilerhouse, as taken from boiler fuel report, shown in section VII of this series.

20—Pound coal per b.hp. hour:

\[
\text{Item No. 19} \times 2,000 \text{ lb.}
\]

21—Pound water evaporated per pound coal:

This is obtained in two ways—

\[
\text{Item No. 19} \times 2,000
\]

\[
34.5
\]

\[
\text{Item No. 20}
\]

22—Efficiency: This is the thermal output and input ratio. Since all fuels are given in terms of coal of 13,500 B.t.u. per lb., this item becomes a simple calculation, by two methods—

\[
\text{Item No. 1} \times 970.4 \text{ B.t.u.}
\]

\[
\text{Item No. 19} \times 2,000 \times 13,500
\]

Since the final figures of fuel consumption of the various boiler houses is converted into equivalent weights of coal, Curve Sheet No. I has been made up for check purposes in the ultimate economy figures in determining the pound of water evaporated per pound coal for various efficiencies. At the same time to check quickly the conversion of the above unit factor (Item No. 21, pound water evaporated per pound coal) to (Item No. 20) pound coal per boiler-horsepower hour, or vice versa, Curve Sheet No. II is shown. A convenient outside source of checking is almost imperative since the time required for the completion of these reports is exceedingly limited.

Curve Sheet No. III gives the fuel required per boiler horsepower, not only for the coal figures used in these reports (Item No. 20), but also for the various other fuels that may be used for steam production purposes for those fuels commonly encountered in the steel mill, in terms of their individual units of measurements.

(Continued on page 1587)
With the Equipment Manufacturer

Hydro-Pneumatic Accumulator

Among the many interesting features of the new Hydraulic Accumulator, manufactured by the John Robertson Co., 121 Water Street, Brooklyn, N. Y., is the low air pressure required. The air tank, holding air at 175 lb. maximum pressure, forms the base of the accumulator. The hydraulic ram is supported by the cross-head above and the hydraulic cylinder and air ram which are floating on the air pressure are guided at the bottom of their respective glands and at the top by the intermediate platen, which in turn is thoroughly guided for the vertical movement.

The hydraulic cylinder is bronze bushed and fitted with a bronze packing gland. Both rams are outside packed with square flax packing.

The limit switch and tell-tale rod provided with the accumulator automatically control the supply pump.

The accumulator is protected from possible failure of the limit switch by a by-pass vent in the hydraulic ram. Cushion springs prevent the operation of this by-pass, except when it is required. An auxiliary air compressor with automatic control maintains air pressure in the air cylinder and storage tanks.

This accumulator may be placed on an ordinary factory floor and does not require a heavy foundation. It occupies a minimum of floor space. Built in sizes from 96 gal. at 1500 lb. pressure to 2½ gal. at 6,000 lb. per sq. in. hydraulic pressure.

The Linatex Valve

The Linatex Valve consists of a cast-iron body lined with Linatex and a cast iron butterfly disc carried on a steel shaft. The valve disc is made slightly larger than the lining, so that when the valve is closed the disc compresses the Linatex and forms a pressure-tight closure.

Linatex is manufactured from fresh rubber latex by the Wilkinson Process and comprises 90 per cent rubber to which has been applied a special chemical treatment. The resulting product has a permanent resiliency and almost unbelievable resistance to abrasion and chemical action. Linatex does not deteriorate with age.

The Linatex Valve has many advantages, among which are the following:

Close-up of the Linatex seat
J-M Insulation that cost $1675

Saves $9064 annually...

In 1928, a prominent steel company applied Johns-Manville Insulation on the regenerator of one of their gas-fired soaking pit furnaces.

Fuel costs compared with a similar soaking pit, not insulated, show a saving of 8.5¢ per ton of ingots...a net annual saving of $9,064.40, which represents a yearly return of 541% on the investment. In other words, the insulation paid for itself in less than 10 weeks’ operation!

Other benefits directly traceable to the J-M Insulation are: (1) Better heat distribution which permits uniform checker chamber temperatures and gives the furnace operator better control over the inlet air temperature; (2) Reduction in the expansion and contraction of the brickwork which means longer life of the regenerator walls.

A “PERFORMANCE REPORT” fully describing this installation will be sent to any plant official interested.

You “Pay” for insulation—whether you buy it or not

In this case, the actual fuel saved completely paid for the insulation in the first 10 weeks. Every 10 weeks since then the entire cost of the insulation has been returned as clear savings.

If your equipment needs insulation, every day you delay in buying it, the fuel you waste represents a down payment on insulation that you ought to have but haven’t—insulation that could easily be saving you money.

Call in a Johns-Manville engineer. He can show you just where insulation can reduce fuel bills. He can determine fuel savings—in advance—with a degree of accuracy that makes J-M Insulation a “sure thing” investment.

Johns-Manville, 292 Madison Avenue, New York City.

Including J-M Sil-O-Cel -Asbesto-Sponge Felted - Superex - 85% Magnesia - Rock Cork - For all temperatures from 400° F. below zero to the highest industrial temperatures.
The valve is absolutely pressure-tight and prevents leakage of any kind without the use of a water seal. It is tighter than a gate valve.

The valve has a non-clogging self-cleaning face and may therefore be used with dirty gas, dirty water or pulverized fuel.

The valve is particularly adapted to resist abrasion and wire drawing.

The action of opening or closing is quick. A minimum effort is required to operate the valve.

The valve is especially adapted for the regulation of volume or flow.

The cost of the Linatex Valve is quite low. The maintenance of this valve is negligible.

The Linatex Valve is particularly adapted for use with blast furnace gas, coke oven gas, natural gas, pulverized fuel, low pressure water, flue dust, and the like. On such applications it displaces the gate valve, cock, mushroom valve, check valve and goggle valve.

There are over 50 installations performing to the entire satisfaction of operators in many industries as well as in central station applications.

The Linatex Valve is covered by patents which are pending. It is offered to the steel industry by Freyn Engineering Company.

Dieform Compression Fittings and Tubing

The need for leak-proof and trouble-free small service lines in the power plant and industrial field has long been felt. Recently the Bailey Meter Company, Cleveland, Ohio, has announced that Dieform compression fittings and tubing are now available for this service.

The illustration shows an exploded view of a Dieform tubing union which illustrates the method in which the joint is made. The left-hand side of the tube union is shown with the tube in place and the tube nut screwed down tightly to complete the metal-to-metal joint, while the right-hand side shows the tube nut unscrewed and slipped back along the tubing, which is the removal of a slight distance from the seat in the fitting. This illustration shows how the tubing is securely gripped between the seat in the center fitting and the seat on the tube nut, resulting in a perfectly tight, dry, permanent joint.

In flaring the tubing the Dieform nut serves as a die, thereby assuring a perfect seat with the angle properly proportioned to the size of the tube. The moderate angle of flare prevents the tube from splitting or cracking and also permits the use of hard drawn tube when desirable.

Brass, monel metal or steel Dieform compression fittings and copper or steel tubing are especially well suited for piping where many bends must be made in the line and where an absolutely tight installation is required for high pressure and high temperature service. With these materials perfectly tight metal-to-metal joints may be quickly made by an inexperienced laborer without thread compound, dies or tools other than a hammer and flaring tool. Joints made in this manner will resist vibrational strains as well as the strains resulting from the expansion and contraction of the tube caused by intermittent temperatures. Owing to the reduction in the number of joints, installation of this material can be made in approximately one-half the time required for an equivalent rigid pipe installation.

Double extra heavy brass fittings with heavy soft annealed or half-hard copper tubing are suitable for pressures which do not exceed 800 lb. per sq. in. and where the intermittent temperatures are under 600 deg. F. Where higher intermittent temperatures are expected, steel or monel compression fittings are recommended. Steel tubing should be used for pressures in excess of 800 lb. per sq. in. if the installation is subject to steam temperatures at intervals, although for hydraulic lines extra heavy copper tubing is satisfactory for pressures up to 2,000 lb. per sq. in.

Dieform fittings and tubing are recommended for all small piping. They may be used with marked economy and satisfaction for connection to metering equipment and for water, oil, steam, compressed air and gas lines.

C-E Multiple Circulation Boiler

The Combustion Engineering Corporation, 200 Madison Avenue, New York, has recently developed a new type of boiler which provides a logical solution to the problem of insuring adequate circulation and correct steam liberation under the most severe conditions of operation. This boiler is now offered to the steam generating industry.

The salient features of this development are as follows: The C-E Multiple Circulation Boiler departs from the conventional design in two essentials—tube arrangement and steam liberation.

The tubes in the first pass of the boiler are arranged so that half of them enter the front drum and the other half enter the middle drum. The tubes in the second pass are arranged so that half of the tubes enter the middle drum and the other half enter the front drum.

This boiler is available in sizes ranging from about 2,000 sq. ft. to 26,000 sq. ft. of heating surface. It is adaptable to any type of firing and may be set double.

The unique tube arrangement effects a double
circulation in the boiler. One circulation is up half the tubes in the front tube-bank to the front upper drum, then down the tubes running into the middle tube-bank to the lower steam and water drum. The other circulation is up the other half of the tubes in the front tube-bank which runs into the middle upper drum then down half the tubes in the middle tube-bank to the lower steam and water drum.

This splitting of the circulation results in equalizing the steam liberation in the upper front and middle drums and thus eliminating the intense turbulence which is present in the conventional types of multiple bent tube boilers, in which the greater part of the steam is liberated in the front drum—consequently, the many disadvantages which accompany such turbulence are also eliminated.

In order to assure dry steam production, the steam circulators are increased in number over the conventional design. A further change in design consists in connecting the steam circulators from both the front drum and the middle drum directly into the rear drum. This design effects two improvements over the conventional boiler, namely, drier steam and greater steam velocity.

**Bottom Cast Practice**

(Continued from page 1576)

Bottom Cast Practice

(Continued from page 1583)

In one experiment on record an attempt was made to maintain a head of metal in the central fountain. An extension was placed on top of the fountain casting and it was hoped that when this was filled with metal it would furnish a reservoir of feed metal similar to that obtained by hot-toping top-poured ingots. After the group of ingots had solidified the fountain was removed for examination. A certain amount of metal had been fed to the ingots, there was no doubt of that; but, of several ingots from this group that were split longitudinally the least amount of pipe found was 9 in. in length. The steel sprues in the runner brick freezes quickly after pouring ceases and effectively seals the ingots against further feeding.

Another practice, and one of doubtful merit, is to freeze the tops of the ingots with water as soon as pouring is completed, and as soon as the top of the ingot has been frozen to pour more metal in the fountain. Some feeding takes place as shown by the fact that an occasional ingot, whose top has not been chilled enough, breaks out when the pressure of the stream of metal is transmitted to it. However, even if steel did reach all the ingots on the second feeding they would pipe no less, because the center of the ingots are molten at this time and contraction is inevitable.

There is considerable question as to the harm of pipe in bottom-cast ingots. The pipe is similarly situated to that in top-pouring ingots but pouring conditions must again be considered before judgment is passed. In the case of bottom-cast ingots the metal on top is coldest when pouring is completed—the reverse of conditions in top casting. Therefore the chances of the top of a bottom-cast ingot forming an air-tight bridge is much greater than in the case of a top-poured ingot. It is generally conceded that the gravity of the defect in bottom-cast ingots has often been over-emphasized. However, it is imperative that blooms or bars from top-cast ingots be cropped sufficiently to remove all traces of pipe.

Segregation in any type of steel ingot is inevitable. It may be minimized by casting as close to the freezing temperature as possible, but this is not practicable in bottom-cast practice where high casting temperatures are necessary. It is likely, however, that segregation is less in bottom-cast ingots than in other types because the cross-section is usually small when compared to top-cast ingots. Segregation is a function of the time required for freezing and the more quickly an ingot freezes the less segregation will result.

(Concluded in February issue)

**Distributing Steam Costs in the Plant**

(Continued from page 1583)

In closing this discussion it might be mentioned that calculations for monthly reports are made with the slide rule. Since no calculation need be finer than any item of measurement, an attempt at extreme accuracy with figures running into many places would not only be a waste of time but might be misleading. If water measurements, blast furnace gas derivations, or any single link in the chain of determinations places a doubt on the third digit—1 per cent of its own figure; the use of correction factors or calculations beyond three numerical places lends an atmosphere of precision that does not exist. The author has no desire to create the impression that considerable care and accuracy can be avoided, for such is necessary since exceptional judgment of vital factors is highly essential in the selection of methods of procuring data by almost purely mathematical means.
TRADE NOTES

The Air Preheater Corporation, manufacturers of the Ljungstrom Regenerative Air Preheater, Wellsville, N. Y., announce that it is now represented in Washington, D. C., by Irving M. Day, with offices in 306 Chandler Building.

The Hanna Furnace Corp., Buffalo, subsidiary of the National Steel Corp., Pittsburgh, has established its own sales departments in New York, Philadelphia and Boston, to take over the sale of its foundry, malleable and silvery pig iron and ferro-silicon. The company was formerly represented in the Eastern territory by Rogers Brown & Crocker Brothers, Inc.

The New York office, at 30 Church Street, will be in charge of C. R. Welles as resident agent. For the past several years he has been associated with the New York office of Pilling & Co. C. E. Trommer, who has been identified with the Rogers Brown organization at New York, will be resident agent at Philadelphia, with headquarters at 902 Packard Building. The Boston office, at 514 Chamber of Commerce Building, will be in charge of S. B. Burke, who formerly represented the Hanna company in New England and is now being transferred from the Buffalo office. These changes are effective October 15th.

The Chicago office of the American Manganese Steel Company has been moved from 333 North Michigan Avenue to Room 1414 McCormick Building, 332 S. Michigan Avenue, with the parent company, American Brake Shoe and Foundry Company. The telephone number is Harrison 0190. As sales representatives, Mr. E. F. Mitchell and Mr. E. R. Dougherty are available there.

Mr. D. W. Peabody, for the past 25 years connected with the Southeastern district office of the General Electric Company in various engineering, sales and executive capacities, announces the opening of consulting engineering offices at 588 Linwood Avenue, Atlanta, Georgia. Mr. Peabody will specialize in mechanical and electrical engineering—making surveys, submitting reports, developing designs and layouts, supervising construction, process and operation, and serving in a general consulting capacity.

Edgar S. Bloom, president of the Western Electric Company, announced recently the acquisition as of November 1st, of the Nassau Smelting and Refining Company and the plant and inventory of the Tottenville Copper Company. These properties were purchased from Benjamin Lowenstein, who founded the business 49 years ago. The plant is located on a 45-acre tract in Tottenville, Staten Island, N. Y., has a floor area of 150,000 sq. ft., and refines about 25,000 tons of non-ferrous metals annually. It employs at present 150 men.

The merger of the George W. Moore Company, of Chicago, with H. W. Caldwell & Son Company, a subsidiary of Link-Belt Company, is announced by Alfred Kauffman, president, Link-Belt Company. The combined units are to be known as the Caldwell-Moore Division, Link-Belt Company. Mr. Max H. Hurd, formerly president of the George H. Moore Company, becomes a vice-president of Link-Belt Company, in charge of the Caldwell-Moore operations. His headquarters will be at 2410 W. 18th Street, Chicago.

Ottis Steel Company, of Cleveland, and West Leechburg Steel Co., West Leechburg, Pa., are two of the most recent additions to the list of rolling mills which have installed complete new equipment for de-scaling hot steel by means of high pressure water sprays. The contract for the main spray control valves as well as the remote control units was awarded to Homestead Valve Manufacturing Co., Coraopolis, Pa.

The American Heat Economy Bureau, Inc., 926-930 Wabash Building, Pittsburgh, Pa., has been appointed exclusive sales representative for the "New Controlled Luminous Flame Burner", manufactured by the Ohio Valley Clay Company, Steubenville, Ohio.

Foote Bros. Gear & Machine Co., of Chicago, opened, on November 1st, a new district office in Milwaukee, at 231 Wisconsin Avenue, Room 1418 Majestic Bldg., in charge of Mr. L. W. Erickson, representative.

Mr. Erickson is a graduate of the University of Michigan and for the last several years has been connected with the W. A. Jones Foundry and Machine Co., in the General Engineering, Estimating and Sales Departments, serving successively in the Chicago, New York and Buffalo offices. He has also had considerable experience in tool and die-making as well as other mechanical arts.

Foote Bros. manufacture the IXL lines of gears and gearing, spur gear speed reducers, "Titan" helical and herringbone speed reducers, "Hygrade" worm reducers, and auxiliary equipment such as racks, sprockets, etc.

The Foster Wheeler Corporation announces the opening of a branch office in Washington, D. C. This office will be equipped to handle inquiries for stationary and marine power plant equipment, and in general, all products of the corporation.

Mr. J. S. Malseed, a sales engineer of long experience, has moved from New York to Washington and will be in charge of the new office. The address is 726 Jackson Place, N. W., and the telephone number, National 9206.
PUBLICATIONS

Forty-eight different types of mechanical stokers, manufactured by the 14 member companies of the Stoker Manufacturers Association, are illustrated and described in a new 40-page condensed catalog prepared by the association and now available for distribution.

The various stokers are grouped into the following classifications: multiple retort underfeed stokers, single retort underfeed stokers, chain grate stokers and overfeed stokers.

The text is limited to engineering descriptions of the various types of machines, and a supplementary section on engineering data relating to modern stoker practice is included.

Copies will be sent upon request to W. V. McAllister, secretary, Stoker Manufacturers Association, foot of Walker Street, Detroit, Michigan.

* * *

Turbo-blowers and Turbo-compressors are now a product of the Allis-Chalmers Manufacturing Co., of Milwaukee, Wis., since this company has acquired the assets of the American Brown Boveri Co., Inc., for many years well known as a manufacturer of these machines. These blowers and compressors are described in bulletin 1907, recently released.

* * *

Mathews Conveyors is the title given an attractive catalog issued by the Mathews Conveyor Company, of Ellwood City, Pa. The catalog gives very complete information in regard to the many different types of conveyors for the handling of sheets, structural shapes, plates, etc., in steel mills. Engineers will find in this well illustrated publication, much helpful data.

* * *

In a bulletin, made especially appealing by its numerous and artistic illustrations, the Pennsylvania Engineering Works, New Castle, Pa., directs attention to the various kinds of products manufactured by the company. In this bulletin will be found, besides a list of products, many illustrations of mill equipment such as blast furnaces, open hearth furnaces, mixers, ladle cars, cupolas, etc.

* * *

Rolls and Rolling Mill Machinery, as manufactured by the United Engineering and Foundry Company, are listed in bulletin 101, recently published. The bulletin briefly sets forth the facilities of the company for serving the steel industry. Steel plant engineers will undoubtedly find this publication of value, especially for reference purposes.

* * *

A positive pressure grease pump for applying heavy lubricating greases to rolling mills and other heavy duty equipment is described in a leaflet issued by the Hills-McCanna Co., of 2349 Nelson Street, Chicago. This company is also distributing

a catalog in which are described the non-ferrous alloys and products manufactured by the company.

* * *

A 172-page catalog, illustrating approximately thirty types of Nordstrom lubricated plug cock valves, has just been issued by Merco Nordstrom Valve Co., 343 Sansome Street, San Francisco, Cal. The catalog lists various types of valves made in different metals for handling different liquids, semi-liquids and gases, both neutral and acid. The catalog also lists steam jacketed valves, remote control valves and types with multi-ports, both in low and high pressure. Valves manufactured of bronze, aluminum and Mercalloy for handling corrosion-resistant liquids are also shown, and the catalog is illustrated with actual installations in approximately twenty industries.

* * *

The Type H Stirling Boiler is the title of a new bulletin issued by the Babcock & Wilcox Company. This publication describes a new boiler, which, the company states, has unusual steaming capacity for the low headroom and floor space required.

The booklet contains full descriptions and setting plans showing installations of the boiler in widely diversified industries, using many different types of firing.

Complete construction details and the many advantages of this boiler are clearly described and illustrated by sketches.

The bulletin is attractively bound and profusely illustrated. Copies of this publication may be had by addressing the Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

* * *

Single stage, double suction centrifugal pumps of the horizontal split casing design are described and illustrated in a leaflet recently published by the De Laval Steam Turbine Company, Trenton, N. J. This type of pump was introduced by that company in 1901, and has become accepted as the standard type of high grade centrifugal pump. It is characterized by relatively high speeds, high efficiencies and the ability to work against high heads per stage. A high degree of reliability, improved accessibility and desirable head-delivery and power-limiting characteristics, adapting this type of pump ideally for electric motor drive, have resulted in its almost universal use in all industries and in water works plants.

* * *

Modern Steam is the subject of a new bulletin issued by the Babcock & Wilcox Company. This publication outlines the evolution of marine steam propulsion from low pressure plants to the present economical use of modern steam.

The bulletin also deals with the economies of steam propulsion from the standpoint of fuel consumption, cost of fuel, lubricating oil costs, flexibility of operation and other important factors.

Copies of this publication may be had by addressing the Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.
News of the Plants

The Azuma Steel Works is planning to manufacture black sheets. A site for the mill has been selected, and the company is inquiring for rolling equipment for a capacity of about 2,000 tons a month. Construction of the mill may be delayed by the recent report that the Nakayama Sheet Steel Works, Japan, is planning to expand its capacity.

* * *

United Engineering & Foundry Company has developed a suction crane for steel, non-ferrous and other flat materials where the surface must be preserved and breaks or buckles are to be avoided, or where a magnet crane is inconvenient or unsuitable.

Possible uses for the suction crane are almost unlimited. It is held to be ideal for thin sheets, high-finished sheets, tin plate, chromium plated sheets, buffed copper sheets and polished stainless strips. It is applicable to paper, cardboard, fibre, wall-board, glass and lumber.

The crane is a self-contained unit, consisting of a series of suction cups, mounted in a bracket suspended from a boom or bridge, or other crane construction. Vacuum is provided by a small motor-driven pump with air lines to the suction cups, the pump running continuously, and the vacuum control being a two-way valve, which either applies the vacuum or lets the air in for release. Lifting power is determined by the size and number of vacuum cups.

* * *

Genuine wrought iron sheets which have not been manufactured on a commercial basis for many years have made their reentry into the roofing and siding market, where corrosion resistance is desirable. In making this announcement, L. F. Rains, President of A. M. Byers Company, states that this new development is in line with the policy of the company to extend the uses of wrought iron. It will be recalled that last October, Byers opened their new mill in Economy Township, Pennsylvania. Byers is making these wrought iron sheets at the plant of the Canonsburg Steel and Iron Works. Sheets are being rolled from ten to 28 gauge, up to 38 in. wide and in lengths up to 144 in. A base price on black sheets of $3.70 carload and $4.10 less carload has been established with the usual sheet extras for gauge, width, length and cutting. Galvanized sheets will carry a base price of $4.45 carload and $4.85 less carload.

* * *

The Brassert-Tidewater Development Corp., of Chicago, a subsidiary of H. A. Brassert & Co. and Tide Water Oil Co., has contracted with the Atlantic Refining Co. for the installation of 12 Knowles Coking Ovens, to coke heavy residues at their Philadelphia refinery. Construction is already under way and the plant will be in operation on March 1, 1932. Besides this installation there are ten Knowles coking ovens operating on the Pacific Coast, six in Mid-Continent Field, and three under construction in Mexico.

* * *

Since the advent of the four-high mill method of rolling steel and non-ferrous metals, considered to be the most practical and economical in industry, United Engineering & Foundry Company, the world's largest maker of rolls and rolling mill equipment, has built such equipment for a total of 50 plants. Seventeen plants now use four-high mill equipment for cold rolling of all kinds of commercial steels, 15 plants now use it for hot rolling of sheets, strips and plates, and 12 plants now use it on non-ferrous metals. Six plants now use this equipment for stainless steel strips, one of the most difficult of rolling mill operations because of the extreme hardness of such material.

A Few Steel Facts

In 1929, 75,603,000 tons of iron ore were mined in the United States, while 56,433,000 tons of steel were produced.

In the same year, the main products of the steel mills were divided as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rails</td>
<td>2,722,000</td>
</tr>
<tr>
<td>Sheets and plates</td>
<td>12,436,000</td>
</tr>
<tr>
<td>Wire rods</td>
<td>3,134,000</td>
</tr>
<tr>
<td>Structural shapes</td>
<td>4,778,000</td>
</tr>
</tbody>
</table>

and the consumption of steel was:

<table>
<thead>
<tr>
<th>Product</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railroads</td>
<td>18.4</td>
</tr>
<tr>
<td>Buildings</td>
<td>14.7</td>
</tr>
<tr>
<td>Automotive</td>
<td>17.6</td>
</tr>
<tr>
<td>Oil, gas and water</td>
<td>9.0</td>
</tr>
<tr>
<td>Export</td>
<td>4.8</td>
</tr>
<tr>
<td>All other</td>
<td>35.4</td>
</tr>
</tbody>
</table>

During the year 1927 there were 602 steel-making establishments in this country, employing 389,278 wage earners, who were paid nearly 646 millions of dollars.

That year the steel production by the important processes was:

<table>
<thead>
<tr>
<th>Process</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bessemer</td>
<td>7,124,000</td>
</tr>
<tr>
<td>Open hearth</td>
<td>48,353,000</td>
</tr>
<tr>
<td>Crucible</td>
<td>5,000</td>
</tr>
</tbody>
</table>
Teletypewriters* are used by The Republic Steel Corporation to co-ordinate the activities of its widely separated mills and offices. The service—typewriting by wire—makes possible a constant flow of typed messages between any or all of the far-off units. Each message is reproduced accurately the moment it is sent.

"We experienced an immediate dollars-and-cents saving after installing Teletypewriters," an official says. "All inter-plant business was speeded. Most important, however, the Teletypewriters allowed us to give even better service to our customers than had been possible before."

Teletypewriter Service is used by every department of this corporation in controlling plant operations. It is especially valuable in the transmission of orders. Details of metallurgical treatment, pricing, credit, delivery dates, shipping instructions, changes in specifications, etc., are exchanged. Errors are eliminated, as each person interested has an identical typewritten copy of every message.

Businesses large and small are using Teletypewriters to connect offices in the same building, buildings in the same city, or offices separated by hundreds or thousands of miles. They effect many economies. Your local Bell Company will be glad to discuss with you this modern method of communication.

*Teletypewriters may be operated by any typist. They are connected by Bell System wires. A message typed on one Teletypewriter is reproduced identically at the same moment on all connected machines.
Sheet and Tinplate Rolls

By J. Selwyn Caswell

(Continued from the November issue)

This matter has been discussed in greater detail in another paper.¹

Although the forces on the wobblers are large, their general effect on the stress condition of the roll is to diminish the stresses which are set up by the rolling load, i.e., the force couples tend to produce bending of an opposite sign to that produced by the rolling loads.

The Loads Set Up by the Deformation of the Iron

The value of the resistance of the material to deformation depends on the following:

The average temperature of the iron.

The draught.

The width of the piece.

The speed of rolling.

The effect of each of these has been discussed in another paper,² and the present purpose is to determine the approximate values of these loads under normal conditions.

Direct measurement of the loads in rolling mills have been made by Puppe³ and Skinkle,⁴ and approximate measurements in sheet and tinplate mills have been made by the writer.¹

The latter measurements were based on the observed stretch of the housings, and also on the measured values of the energy input to the mills.

The maximum values which were found for the roughing and finishing "pairs" in a tinplate mill are recorded in the next column.

The larger value of the load per foot length along the bar, in the foregoing, as compared with the tinplate mill value, is principally due to the difference in the roll diameters, viz., 30 against 21 ins. With a constant draught, increase of roll diameter increases the area of contact between the "piece" and the roll face. The relationship between the loads and the roll diameters for a constant draught is discussed below.

The Relation between Load and Roll Diameter with Constant Draught

Let \( R = \) Total load due to the deformation of the "piece", in tons.

\( f_b = \) Apparent plastic stress in tons per sq. in.

\( b \) = Width of the "piece", inches. (This corresponds to the length of the original bar.)

\( S \) = Projected length of the contact area, inches.

\( \theta \) = Angle of contact, radians.

Table II—Probable Maximum Loads in a Tinplate Mill

<table>
<thead>
<tr>
<th>Part</th>
<th>Roughing</th>
<th>Finishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass</td>
<td>Bars</td>
<td>Doubles</td>
</tr>
<tr>
<td>Length</td>
<td>in.</td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>8</td>
<td>32</td>
</tr>
<tr>
<td>After</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>Thickness</td>
<td>in.</td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>0.813</td>
<td>0.204</td>
</tr>
<tr>
<td>After</td>
<td>0.59</td>
<td>0.125</td>
</tr>
<tr>
<td>Draught</td>
<td>in. long</td>
<td>tons</td>
</tr>
<tr>
<td>Probable total load for bar 20( \frac{1}{2} ) in. long, tons</td>
<td>500</td>
<td>420</td>
</tr>
<tr>
<td>Load per inch along roll face, tons</td>
<td>24</td>
<td>20</td>
</tr>
</tbody>
</table>

Table III will appear in next issue)

Abstract of paper before the South Wales Institute of Engineers, 1930. For the full text of the paper, see Proc. South Wales Institute of Engineers, v. 46, p. 310-432.

References


At the Central Steel & Iron Company plant, Harrisburg, P.a., George C. Martin superintends roll turning and design

(To be continued)
Ralph D. Nye, recently chief engineer, Wheeling Mold & Foundry Co., Wheeling, W. Va., has joined Lewis Foundry & Machine Co., Pittsburgh, being engaged in sales and engineering work.

William P. Witherow has resigned as vice-president of the Republic Steel Corp., Youngstown, to devote his time to private interests. Mr. Witherow was president of the Witherow Steel Corp., Pittsburgh, prior to its merging with the Donner Steel Co., Buffalo, after which he served as chairman of the board of the Donner company. He has been vice-president of the Republic organization since it absorbed the Donner company early in 1930. Mr. Witherow is a director in the Spencer Mfg. Co., Spencer, Ohio, the Mid-West Forge Co., Cleveland, the Pittsburgh Coal Co., Pittsburgh, the First National Bank at Pittsburgh, and the Peoples-Pittsburgh Trust Co. He is also vice-president of the Chamber of Commerce of Pittsburgh, and prominently identified with many other civic and business affairs in that city.

M. A. Grossman has severed his connection with the Republic Research Corp. and is now with the Illinois Steel Co., at South Chicago, Ill.

Edward R. Hall, vice-president and general manager of the Western Gas Construction Company for the past two years, was recalled to Baltimore, Md., to manage the shops of the Bartlett Hayward Company.

Thomas W. Stone, vice-president of the company for several years, has succeeded Mr. Hall as general manager there. He has been associated with the Western Gas Company for 20 years, having served in various capacities in the engineering department during his career. For many years he was chief engineer, from which position he was promoted to the office of vice-president.

C. F. Herington, formerly sales engineer for Heyl & Patterson, Inc., Pittsburgh, is now associated with the Whiting Corporation as assistant vice-president of the powdered coal division. Mr. Herington will give his attention to the sale of furnaces and powdered coal equipment.

L. U. Murray, district manager of the industrial department, east central district, of the General Electric Company, with headquarters at Cleveland, has been appointed manager of the Graybar-Western Electric department, with headquarters there, according to an announcement by J. G. Barry, vice president, effective October 15. Mr. Murray succeeds R. S. Johnston, deceased.

J. P. Jones, manager of the machinery manufacturers section of the industrial department, has been appointed district manager of the industrial department, east central district, to succeed Mr. Murray.

A. W. Thompson, who for the past five years has been Pacific Coast Manager in charge of sales for Fairbanks, Morse & Co., has been appointed vice-president in charge of manufacturing, according to an announcement made public by W. S. Hovey,
president. Mr. Thompson succeeds Mr. Heath, who resigned November 1st.

William H. Jacobi, formerly general manager of the Keokuk Steel Casting Co., Keokuk, Iowa, subsidiary of the Springfield Boiler Co., Springfield, Ill., is now affiliated with the Continental Roll & Steel Foundry Co., East Chicago, Ind., in the capacity of Sales Engineer, specializing in cast steel pressure vessels and fittings of all kinds, both rough and finished.

R. L. Gray was elected president of the Sheffield Steel Corporation, Kansas City, Mo., on November 3rd. He has been vice president and general manager of that company since its organization in 1925. He was formerly vice president of the Kansas City Bolt and Nut Company, predecessor to the Sheffield Steel Corporation. Mr. Gray came to the Kansas City Bolt and Nut Company in 1923, when the management of that company was taken over by W. L. Allen as its president. Allen was elected Sheffield’s Chairman of the Board, a newly-created position, on November 3rd.

Ralph Leavenworth has been appointed general advertising manager of the Westinghouse Electric & Manufacturing Company, according to an announcement made by J. S. Tritel, vice president and general manager. He will have charge of all advertising and publicity activities of the company, the announcement reads, including the advertising division of the merchandising department, now centered in Mansfield, Ohio.

The business career of Mr. Leavenworth, prior to his association with the Westinghouse Company, has been one in which sales and advertising administrative work have been closely paralleled.

Graduating from Hamilton College, Clinton, N. Y., in 1914, he became associated with the Y. M. C. A., with headquarters in Cleveland and remained with that organization four years. After the war he joined the Standard Parts Company, also located in Cleveland, and except for a short period, during which he served as personnel director for a publishing firm, he was advertising manager of this concern until 1923. In that year he became an account executive for Paul Teas, Inc., an industrial advertising agency. He remained with this firm six years, becoming in that time part owner of the company.

W. H. Donner, formerly head of the Donner Steel Co., Buffalo, now a unit of the Republic Steel Corp., denies a report that he is negotiating for the Wickwire Spencer Steel Corp.

High Capacity Coal Pulverizer at Kips Bay

A remarkable record for coal pulverizers was recently established when a Fuller Lehigh Type B Mill pulverized 50 tons of coal per hr. at the Kips Bay Station of the New York Steam Corporation, New York City.

The mill is driven by a direct-connected 500 h.p. vertical synchronous motor and occupies a floor space of only 14 ft. 6 in. in diameter.
Uniformly Rich Gas at Low Cost

The uniform distribution of fuel in small quantities by the gas-tight coal feeder; the constant mechanical agitation of the entire fuel bed resulting in rapid gasification and the continuous ash removal which maintains the fuel bed at a constant level, are the operation features of the “WOOD” fully Automatic Gas Producers which ensure a steady flow of uniformly rich gas at low cost. As operation is automatic, labor charges are reduced to the minimum. The large gas output decreases the number of producers required. The cost of maintenance is almost negligible.

Write for full information. We will arrange for you to inspect an installation in regular operation, where these advantages will be demonstrated.

R. D. WOOD & COMPANY
PHILADELPHIA
Designers and Builders of Mechanical Gas Producers since 1889

Lower Hauling Costs

ATLAS CARS

Builders of

Ore Transfer and Blast Furnace Charging Cars, Scale Cars, and Weighing Cars of all kinds. Atlas Patented Indicating and Recording Mechanism for Scale Cars.

Storage Battery Locomotives, Electrically operated Industrial Cars.

Special Industrial Cars of all kinds, Turntables, Kiln Cars.

Industrial Trucks and Tractors.

Complete Coke Oven Equipment
Pushers and Levelers, Charging Cars, Door Handling Machines, Coke Quenching Cars.

THE ATLAS CAR & MANUFACTURING CO.
Engineers Cleveland, Ohio
Manufacturers

More Satisfactory Service


Combined Pusher, Leveler, and Door Machine.
Sleicher Joins General Refractories Co.

Harry S. Sleicher, formerly vice president of the North American Refractories Company, has severed his connection with that company and is now associated with the General Refractories Company in a sales capacity, with headquarters in the New York office of the latter company.

Relative Heat Transfer Through Refractories

The latest publication of the Engineering Experiment Station is Bulletin 64, entitled "Relative Heat Transfer Through Refractories", by A. S. Watts and R. M. King, Department of Ceramic Engineering at The Ohio State University.

This bulletin covers the development of a practical control method for the determination of relative heat transfer through refractories. It also includes thirteen tables of data on composition, temperature gradients, insulating values, heat transfer values, and porosity of a number of samples of brick furnished by many well-known manufacturers of refractories.

A critical analysis of the method used in this investigation, made by H. L. Johnston, Department of Chemistry at the University, is included as the appendix of Bulletin 64. A theoretical and practical discussion of the data is presented by the authors.

Copies of this bulletin, which is in press and shortly to be issued, may be obtained by writing the Director of the Station.

R. S. Baker Now With Electro Refractories

R. S. Baker is now associated with the Electro Refractories Corporation, in charge of refractory sales in the Chicago territory. Mr. Baker was formerly connected with the Carborundum Company in the Chicago territory, in the refractory division.

Firebrick Factory Opened in Podolsk

A large firebrick factory, one of the 518 new enterprises to open this year, began operations in September at Podolsk, in the Moscow Region. The plant will have a capacity of 30 million firebricks a year.

W. B. McQuiston Represents King Refractories Company

W. Bryce McQuiston, until recently associated with the Kier Fire Brick Co., Pittsburgh, Pa., has become affiliated with the King Refractories Co., Buffalo, N. Y., in the capacity of district representative in Western Pennsylvania.

O. M. Reif, of Harbison-Walker, a Director

O. M. Reif, vice president, Harbison-Walker Refractories Company, Pittsburgh, who retired several years ago from active management in the company, has resigned, but remains a director. P. E. Mossman has been elected a director and vice president, in charge of finance.

Low Thermal Expansion Ceramic

A remarkable scientific development in the form of a ceramic possessing the lowest coefficient of thermal expansion of any known material, is announced by Henry L. Crowley & Company, of West Orange, N. J. Known as Crolite No. 7, the new ceramic enjoys a two-to-one advantage in thermal coefficient over Invar, an alloy heretofore representing the lowest thermal coefficient, and a four-to-one advantage at 100 deg. (two-to-one at 1,000 deg.) over Sillimanite, the ceramic employed for spark plug cores and other purposes. The new product is the result of intensive and extensive research in the Crowley laboratory.

Crolite No. 7 has a coefficient of thermal expansion of 0.9 at temperatures ranging from 0 to 100 deg. C., and 1.2 from 0 to 200. At high temperatures, or up to 1000 deg. C., the coefficient of thermal expansion is 2.7. Invar is 1.5 for temperatures from 0 to 100 deg. C. The thermal expansion curve of Crolite No. 7 is absolutely smooth and uniform.

The lowest coefficient of expansion attained in Crolite No. 7 means that this material undergoes less change in size for temperature variations than any other material now in use. Also, the absence of appreciable thermal expansion means that the material is free from internal stresses and can therefore be subjected to severe heat shock without cracking. In fact, it will not be destroyed even when heated to incandescence and then plunged into cold water.
**IMPROVED** Lavino Chrome Brick have these advantages:

- Less spalling and cracking. (Tests show the spalling loss of these IMPROVED Brick to be 75% less than any other Chrome Brick.)
- Greater resistance to penetration of destructive elements.
- Higher hot load strength.
- Much greater resistance to abrasion and erosion.
- A sagging point 300° F. above any Chrome Brick heretofore produced commercially.

A recent survey on the use of Chrome Brick in the Pittsburgh District shows that 4 out of every 5 plants use Chrome Brick in their Soaking Pits, and of these, 2 out of every 3 use LVINO.

**Use IMPROVED Lavino Chrome Brick in Your Soaking Pits**

They spall less than Magnesite Brick.

Their expansion is one-half the expansion of Magnesite Brick.

In addition to longer service life, you obtain a saving in first cost of more than $65.00 per thousand by using IMPROVED Lavino Chrome Brick in place of Magnesite Brick.

**E.J. LAVINO AND COMPANY**

**REFRACTORIES DIVISION**

**CHROME, MAGNESITE AND SILICA REFRACTORIES**

**BULLITT BUILDING PHILADELPHIA**

"Pioneers in Chrome Refractories"
Furnace Walls

By George P. Reintjes
President of the George P. Reintjes Company

(Continued from November Issue)

We frequently hear it said that the brickmason today does not lay the number of brick his forefathers did. In a way, this is incorrect. The writer's experience as a contractor dates back to the days when the mason laid 3000 brick a day, but conditions have changed, not the men. In those days, the average red brick weighed 5 lb. against 6 lb. today. We then used lime mortar instead of cement mortar. A trowel of lime mortar weighing the same as a trowel of cement mortar would spread for seven brick without drying. Today a trowel of cement mortar will spread for only four brick. In the present day, with our thin walls, on a 13-in wall two-thirds of the brick are laid to a line, whereas in the old days with the walls 3 to 4 ft. thick, the outer courses acted as a backstop, allowing the mason to practically dump the balance of the brick into the inner courses. Also, in the good old days, owing to the amount of wastage in the brick, the legal count of brick was 22½ brick per cu. ft. while today brick are computed at 18½ brick per cu. ft. All in all, it is our experience that the mason today works harder while laying numerically less brick, than he did in former days.

Many wall failures attributed to the materials, the design, or a hundred other causes, are nothing more than a lack of knowledge of the reactions of heat to the furnace wall by the erecting mason.

Aircooled—Solid Walls

As mentioned in a previous article, furnace walls are enclosures in which is generated the heat of combustion from fuels, also which retain that heat and products of combustion until the heat units have been transferred to the product to be heated.

Until shortly following the World War, practically no changes had been accepted, the brick walls being built the same as they were when the Mings repaired the Great Wall of China. It is true that many spasmodic attempts had been made to improve the structures, but they failed to be adopted commercially. The only difference between furnace walls up to this time and the walls of the Ancients was that a slight veneer of refractory brick was placed in front of the red brick to reduce the amount of spalling and abrasion.

During the trying times of the World War, the

Fuel Conservation Board appointed by the late
President Wilson, and consisting of the leading
combustion engineers of the country, made a careful
study of the losses in the boiler room. They dis-
covered that a great amount of additional heat units
could be taken from the fuel if they would only in-
crease the furnace volume. In other words, prior
to that time it was the general opinion that the boiler
alone produced the fuel economy. The brick fur-
nace was ignored.

When the furnace walls were increased in height
to accommodate the additional furnace volume, new
problems were encountered, namely:

The increased temperatures in the furnace re-
quired more refractories in the walls.

The weight of the higher walls imposed addi-
tional strains on the heated brick.

Leakage of excess air was detrimental to the
economies obtained.

Expansion and shrinkage of brick.

Supported walls were developed around discov-
eries made in air circulation and the use of a com-
bination of metal and refractories, during the middle
of the last century. Unfortunately for the inventors,
these discoveries were made before their need was
apparent. The British were most active in the de-
velopment of air circulation through walls, from the
year 1846 to 1875.

Increased furnace efficiency gradually led to two
major designs of wall. First, one designed to re-
duce as much as possible the radiation losses through
the walls; second, a wall designed to cool the re-
fractories by increasing the radiation loss.

(To be continued)
December, 1931

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Metsa Machine Co.
Morgan Engineering Co., The
United Eng. & Fdry. Co.
Wood & Co., R. D.
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Linde Air Products Co., The
Acetylene Generating Apparatus.
Linde Air Products Co., The

Acid-Proof Products.
Harbison-Walker Refractories Co.
Johns-Manville Corp.
Michiana Products Corp.
Michigan Steel Castings Co.
Standard Alloy Co., Inc.
Union Steel Casting Co.

Annealing Furnaces and Ovens.
Combustion Engineering Corp.
General Electric Co.
McCann-Harrison Co.
Morgan Construction Co.
Rockwell Co., W. S.
Rust Engineering Co., The
Surface Combustion Corp.

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Blaw-Knox Co.
Carey Co., The Philip
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Argon.
Linde Air Products Co., The

Asbestos Lumber.
Carey Co., The Philip
Johns-Manville Corp.

Ash Conveyors.
Combustion Engineering Corp.
Linde Co.

Automatic Control—Gas Pressure and Flow.
Bailey Meter Co.
Shallcross Control Systems Co.

Baffles—Monolithic.
General Refractories Co.
Harbison-Walker Refractories Co.
Johns-Manville Corp.
Quigley Co., Inc.

Balls—Cast Iron Chilled.
Puller Lehigh Co.

Bearings and Hangers—Shifting.
Link-Belt Co.
Tinkon Roller Bearing Co.

Beaters.
Hiller, Joseph L.

Bell Roost.
Frey Engineering Co.

Belt Conveyors.
Link Belt Co.

Benches—Draw Wire, Rivet and Bolt Works.
Morgan Construction Co.

Benches Recovery Plants.
Bartlett Hayward Co., The
Koppers Construction Co., The

Beasemen Tuyeres.
Climax Fire Brick Co.

Blast Furnaces.
Frey Engineering Co.
McClintic-Marshall Corp.
McKee & Co., Arthur G.
Moir & Sons, John

Blast Furnace Specialties.
Bartlett Hayward Co., The
Broinor, Inc., Edgar E.

Blast Gates.
Rockwell Co, W. S.

Brick—Nozzles, Sleeves and Runner.
Johns-Manville Corp.
Swank's Sons, Inc., Hiram

Brick—Silica.
General Refractories Co.
Harbison-Walker Refractories Co.
Lavino & Co., E. J.

Brick—Silicon Carbide.
Carborundum Co., The

Brick—Steel Plant.
Blast Furnaces.
Climax Fire Brick Co.
Harbison-Walker Refractories Co.

Brick—Tubing.
Linde Air Products Co., The

Buckles—Automatic Dump.
Brosius, Inc., Edgar E.
McClimic-Marshall Corp.

Buckles—Clamshell, Drag Line, Grip, etc.
Blaw-Knox Co.
Brosius, Inc., Edgar E.
Link-Belt Co.

Buckstays—O. H.
Blaw-Knox Co.
National Roll & Fdry. Co.

Buildings—Portable Steel.
Blaw-Knox Co.

Bulkheads—O. H.
Blaw-Knox Co.
National Roll & Fdry. Co.

Burners.
Combustion Engineering Corp.
Hagan Co., George J.
Rockwell Co., W. S.
Surface Combustion Corp.
Swindell-Dresser Corp.

Burners—Boiler.
Anthony Co., The
Ohio Valley Clay Co., The
Surface Combustion Corp.
Swindell-Dresser Corp.

Burners—Powdered Coal.
Combustion Engineering Corp.
Puller Lehigh Co.

By-Product Coke and Gas Oven Plants.
Koppers Construction Co., The

By-Product Recovery Plants.
Bartlett Hayward Co., The

Calcium Carbide.
Linde Air Products Co., The
Gathmann Engineering Co.

Calcium Silicon.
Electro Metallurgical Sales Corp.

Calcium-Aluminum-Silicon.
Electro Metallurgical Sales Corp.

Calcium-Manganese-Silicon.
Electro Metallurgical Sales Corp.

Carbon Burning Equipment—Acetylene.
Linde Air Products Co., The

Cars—Charging and Ingot Mold.
Mackintosh-Hempfith Co.
Metsa Machine Co.
Michigan Products Corp.
Morgan Engineering Co., The
United Eng. Steel Casting Co.,
Wellman Eng. Co.
December, 1931

**Blast Furnace & Steel Plant Buyers Guide**

### Cars—Dump

### Cars—Hot Metal
- Blaw-Knox Co.

### Cars—Industrial

### Cars—Scale and Ladle Transfer


### Castings—Alloy
- Michigan Products Corp.
- Union Steel Casting Co.

### Castings—Electric Steel
- Link-Belt Co.
- Michigan Steel Castings Co.

### Castings—Grey Iron
- Blaw-Knox Co.
- Lewis Foundry & Machine Co.
- Link-Belt Co.
- Michigan Steel Castings Co.
- National Roll & Fdry. Co.
- Poole Engineering & Machine Co.

### Castings—Malleable Iron
- Link-Belt Co.

### Cement
- General Refractories Co.
- Lavino & Co., E. J.

### Concrete—Steel Forms for Construction
- Blaw-Knox Co.

### Condensers
- Blaw-Knox Co.

### Cooling Beds
- Lewis Foundry & Machine Co.
- Mackintosh-Hemphill Co.
- Morgan Construction Co.
- Morgan Engineering Co., The

### Cooling Plates
- Blaw-Knox Co.

### Cooling Tables
- Blaw-Knox Co.

### Coupling Boxes
- Lewis Foundry & Machine Co.
- Mackintosh-Hemphill Co.
- Mesta Machine Co.
- National Roll & Fdry. Co.
- Union Steel Casting Co.

### Couplings—Flexible

### Couplings—Rigid
- Link-Belt Co.

### Couplings—Universal
- Lewis Foundry & Machine Co.
- Mackintosh-Hemphill Co.
- Mesta Machine Co.

### Coverings for Cold Pipes
- Link-Belt Co.
- Morgan Engineering Co., The

### Cranes
- Mesta Machine Co.
- Union Steel Castings Co.

### Crushers—Coal
- Full Lehigh Co.

### Crushers—Roll
- Fuller-Lehigh Co.
- Link-Belt Co.

### Cup Grease
- Keystone Lubricating Co.

### Cupola Linings
- Climax Fire Brick Co.
- General Refractories Co.
- Harbison-Walker Refractories Co.
- John Manville Corp.

### Controllers—Automatic for Cranes
- Cutler-Hammer, Inc.
- General Electric Co.

### Controllers—Automatic
- Cutler-Hammer, Inc.

### Controllers—Enclosed Drum Type
- Cutler-Hammer, Inc.

### Controllers—Manual
- Cutler-Hammer, Inc.
- General Electric Co.
- Link-Belt Co.

### Controllers—Electric
- Cutler-Hammer, Inc.
- General Electric Co.

### Controllers—Electric for Steel Mill Machinery
- Cutler-Hammer, Inc.
- General Electric Co.

### Controllers—Magnetic
- Cutler-Hammer, Inc.

### Controllers—Manual, Automatic, Machine Tool, Crane Coal and Ore Bridges
- Cutler-Hammer, Inc.
- General Electric Co.
- Morgan Engineering Co., The

### Controller Valves
- Bailey Meter Co.
- Bristol Co., The

### Conveyors—Billet
- Link-Belt Co.
- Morgan Construction Co.

### Conveying System—Fuller-Kinyon for Pulverized Coal
- Full Lehigh Co.
Cutouts

Cut Bar Carrier.
Blaw-Knox Co., Link-Belt Co.

Cutting Apparatus—Oxy-Acetylene.
Linde Air Products Co., The

Dampproofing.
Carey Co., The Philip John Maxville Co.

Decarburizing Equipment.
Linde Air Products Co., The

Digesters.
Blaw-Knox Co.

Doors—Open Hearth.

Draft Control.
Shallcross Control Systems Co.

Draft Fans.
Air Preheater Corp., The

Drawbench, Tubes and Bars.
Aetna-Standard Engineering Co.

Driers—Direct Heat.
Combustion Engineering Corp., Fuller Lehigh Co.

Driers—Indirect Heat.
Combustion Engineering Corp., Fuller Lehigh Co.

Driers—Rotary.
Combustion Engineering Corp., Fuller Lehigh Co.

Drives—Chain.
Link-Belt Co., Morse Chain Co.

Drives—Gear, Rope.
Poole Bros. Gear & Mach. Co., Gears and Forgings Inc.

Drives—Mill.

Dynamicometers—Gas Engine Testing.
General Electric Co.

Dynamometers.

Economizers.
Combustion Engineering Corp.

Electric Furnaces.

Efficiency Instruments.
Bailey Meter John.

Electric Insulation.
Johns-Manville Corp.

Electric Light Equipment.

Electric Locomotives.

Electric Motors.

Electric Ovens.

Electric Steam Boilers.
General Electric Co.

Electric Welding Apparatus.

Elevators and Conveyors.
Link-Belt Co.

Engineers—Consulting.

Engineers—Contractors.

Engineers—Welding.

Engineering and Contractors.
Bartlett Hayward Co., The M. Morgan Construction Co.

Fire Brick.
Climax Fire Brick Co.

Fire Brick Cement.
Carbonadum Co., The General Refractories Co.

Fire Clay.
General Refractories Co.

Fire Clay Dust.
Harbison-Walker Refractories Co.

Fire Extinguishers.
Johns-Manville Corp.

Fireplaces—Underground.
Johns-Manville Corp.

Fireproofing.
Link-Belt Co.

Fibre Cloth—Underground.
Johns-Manville Corp.

Fibre Conduit—Underground.
Mesta Machine Co.

Ferro Alloys.
Electro Metallurgical Sales Corp., Lavino & Co., E. J.

Ferro-Chromium.
Electro Metallurgical Sales Corp.

Ferro-Manganese.
Electro Metallurgical Sales Corp.

Ferro-Silicon.
Electro Metallurgical Sales Corp.

Ferro-Zirconium.
Electro Metallurgical Sales Corp.

Forms—Welded Chain, Wire and Shafting.
Morgan Construction Co.

Forgings—Marine, including Line, Thrust, Propeller, and Crank Shafts.
Mesta Machine Co.

Forms—Steel for Concrete Construction.
Blaw-Knox Co.

Friction Blocks.
Johns-Manville Corp., Morgan Construction Co.

Fuel Oil—Strainers.
Anthony Co., The

Furnace Alloys.
Michiana Products Corp.

Furnace Builders.

Furnace Engineering.
Morgan Construction Co., The General Refractories Co.

Furnace Stoves.
Wean Engineering Co., The Surface Combustion Corp.

Forgings—Plain Carbon or Alloy Steel.
Gears and Forgings Inc., Mesta Machine Co.

Furnace Walls—Water Cooled.
Combustion Engineering Corp., Puffert Lehigh Co.

Furnaces—Annealing and Case Hardening.

Furnaces—Forging, Heat Treating.

Footnotes:
December, 1931
Blast Furnace & Steel Plant

**BUYERS GUIDE**

**Furnaces—Heating.**
- McCan-Harrison Corp., Rockwell Co., W. S.
- Rust Engineering Co., The Surface Combustion Corp., Wean Engineering Co.

**Furnace Insulation.**
- Carey Co., The Philip Johns-Manville Corp.

**Furnaces—Lead, Pot and Muffle Annealing Wire Mill.**
- Rust Engineering Co., The Wean Engineering Co.

**Furnaces—Metallurgical.**
- Rust Engineering Co., The Wean Engineering Co.

**Furnaces—Normalizing.**
- McGann-Harrison Corp., Wean Engineering Co.

**Furnaces—Pack.**

**Furnaces—Pair.**
- McGann-Harrison Corp., Wean Engineering Co.

**Furnaces—Pulverized Coal.**
- Combustion Engineering Corp., Fuller Lehigh Co.

**Furnaces—Recuperative.**
- Rust Engineering Co., The Surface Combustion Corp.

**Furnaces—Reheating.**

**Furnaces—Sheet and Tin Mill.**
- McGann-Harrison Corp., Wean Engineering Co.

**Furnaces—Soaking Pits.**
- Rust Engineering Co., The

**Fuses and Fuse Specialties.**

**Galvanizing Kettles.**

**Gas—Automobile and Tractor Lighting.**
- Linde Air Products Co., The

**Gas Burners.**
- Freyn Engineering Co., Rockwell Co., W. S.
- Swindell-Dresler Corp.

**Gas Cleaning Plants.**

**Gas Holders.**
- Bartlett Hayward Co., The

**Gas Oven Plants.**
- Koppers Construction Co., The

**Gas Plant Machinery.**
- Bartlett Hayward Co., The Link-Belt Co.

**Gas Plants—Coal.**
- Bartlett Hayward Co., The

**Gas Plants—Water Blue.**
- Bartlett Hayward Co., The

**Gas Plants—Water Carburetted.**
- Bartlett Hayward Co., The

**Gas Producers.**

**Gas Scrubbers.**
- Bartlett Hayward Co., The H. A. Brassert & Co.

**Gas Valves.**

**Gas Washers.**

**Gas—Welding and Cutting.**
- Linde Air Products Co., The

**Gases—Argon, Helium, Neon.**
- Linde Air Products Co., The

**Gaskets.**
- Johns-Manville Corp.

**Gasoline Absorption Plants.**
- Bartlett Hayward Co., The Koppers Construction Co., The

**Gases—Acetylene, Oxygen.**
- Linde Air Products Co., The

**Gases—Pressure, Draft, Volume.**
- Bailey Meter Co., Horstol Co., The

**Gear Drives—Herringbone.**

**Gears—Bevel.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Beveling.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Closed.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Decoiling.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Dual.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Duplex.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Epicyclic.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Flame Cutting.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—French.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Gearbox.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Geared.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Gearless.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Open.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Plain.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Profile.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Reduction.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Universal.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Gears—Worm.**
- Freyn Bros., Gear & Mach. Co., Gears and Forgings Inc., Simonds Manufacturing Co., The

**Generators—D.C. and A.C.**

**Generators—Electric Steam.**
- General Electric Co.

**Glove Welding.**
- Linde Air Products Co., The
Instruments—Indicating and Efficiency.

Hydraulic Valves.

Hydraulic Packing.

Housing Screw Boxes.

Simonds Manufacturing Co., The

Housing Screws.

Allis-Chalmers Mfg. Co.

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Kilns—Cement.

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Insulating Materials—Varnish, Sheet, Tape Compound.

Machines—Welding, Oxy-Acetylene.

Machining, Tapping, Pointing and Threading.


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Wen Engineering Co., Inc. The 1527
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Hole Stopped At Full Pressure; No Interruption to Furnace Operation; A Great Saving in Clay!

The BROSIOUS Hydro-Electric Clay Gun is designed to meet the demands of blast furnace operators wishing to dispense with the use of steam on the furnace front.

It is operated by a single 20-h.p. motor and a fluid pump, both located outside the cast house, away from danger of break-outs, tuyere blow-outs, etc.

The clay is delivered into the hole at a high pressure and comparatively slow speed, giving long, strong, tapping holes and requiring less clay to maintain the hole.

The system is simple, dependable, and noiseless in operation. Maintenance and first cost are surprisingly low! Write for Bulletin No. 50.

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THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Timken Tapered Roller Bearings