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THE BOILER MAKER

JANUARY, 1910

A MODERN BOILER SHOP.

The design of a factory for building steam boilers and doing the kind of sheet-metal work allied thereto is not as intricate a problem as that of most other lines of manufacture. There were some interesting features, however, connected with the building of a recent plant that may be of service to others. As an illustration of a modern factory of this kind the following description of the Heine Safety Boiler Company's new shop at St. Louis, Mo., is presented.

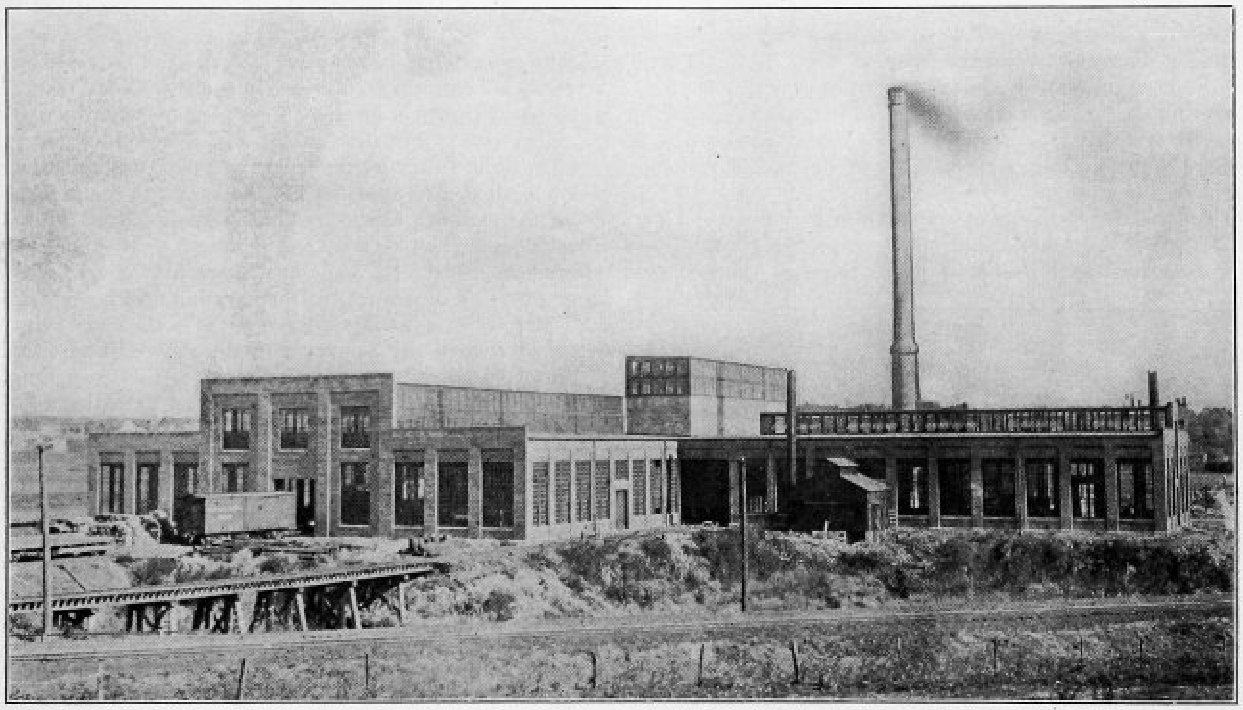


FIG. 1.—GENERAL VIEW OF THE NEW SHOPS OF THE HEINE SAFETY BOILER COMPANY, ST. LOUIS, MO.

LOCATION, GENERAL ARRANGEMENT AND TYPE OF BUILDING.

The property on which the shop is located lies at the intersection of East Marcus avenue and the West Belt of the Terminal Railway, a double-track main line. In shape it is a trapezoid, one end being perpendicular to the sides, the other being at an angle of about 45 degrees. The four sides are, respectively, 259, 512, 771 and 836 feet; an area of 6½ acres. It is along the oblique side that the railroad passes, Marcus avenue being the boundary of the short side. A small stream runs approximately along the railway property line (Fig. 4). The original surface of the ground sloped from an elevation at the creek bank of 24 feet above city datum to 67 feet at the inner corner. The grade was fixed at 47 feet, that being the elevation of the railway tracks. To prepare the ground for building it was necessary to excavate the higher and fill in the lower portion of the site. There was just about enough material to fill in as much of the lot as was required for immediate use, leaving a considerable area for the future disposition of cinders, etc. The stream was straightened in two places. A large municipal trunk sewer will soon be built along its course, after which the entire area will be available for such use as may be desired.

A reinforced buttressed concrete retaining wall, with a maximum height of 19½ feet above grade at the corner and stepped down on the end and side, following the slope of the hill, is built 4 feet inside the property line, so as to keep the wide footings within the site. This wall forms a part of the end and side of one of the buildings.

The buildings consist of a main shop, flange shop (which is a wing of the main shop), power house, toilet and wash house, oil house and general office, totaling about 2¼ acres of floor space. The relative locations are shown on Fig. 4.

The shape of the property made the location of the switch connections simple and convenient. They enter with long radii curves, becoming tangents parallel to the buildings before reaching them. At present there are two switches, one of which enters the main shop and is the shipping track; the other passes alongside of the main shop between it and the flange shop and power house, and is the receiv-

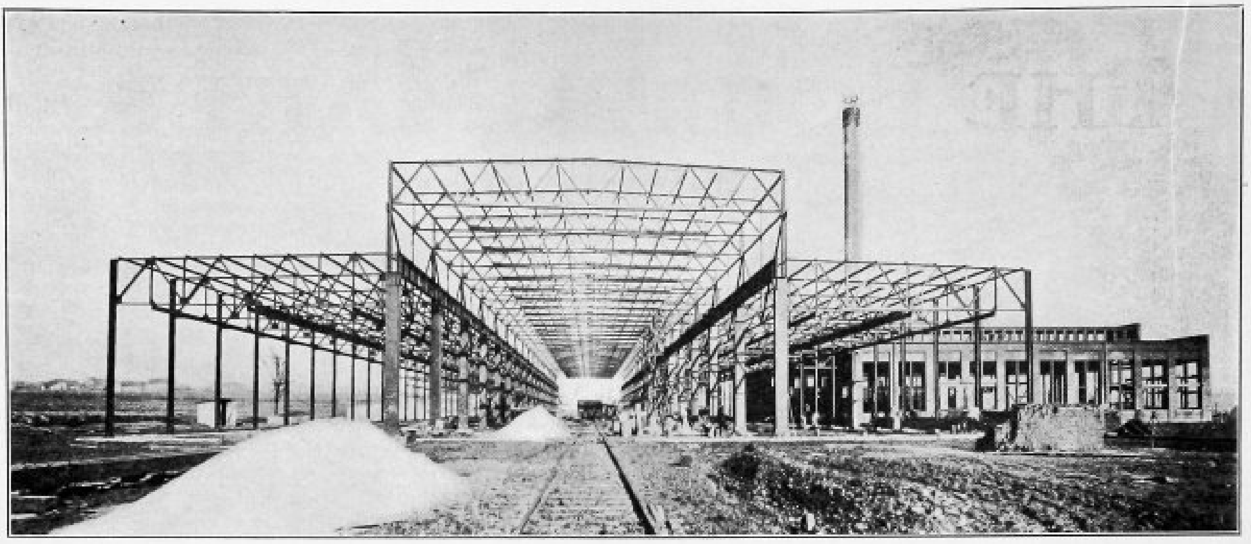


FIG. 2.—STEEL FRAMEWORK OF MIDDLE AND SIDE BAYS, WITH THE FLANGE SHOP AND POWER HOUSE AT THE RIGHT.

ing track. It is anticipated that another switch will be placed along the opposite side of the main building when conditions demand. A 100-ton, 42-foot extra heavy Howe track scale is located on the railway right of way near the connection to the main track.

The office building is on the opposite side of the property facing Marcus avenue, far enough away to avoid serious interference from the noises of the shop.

In general the raw material is received at the far end of the large building, that being the storage space. During the manufacturing processes it passes without reversal to

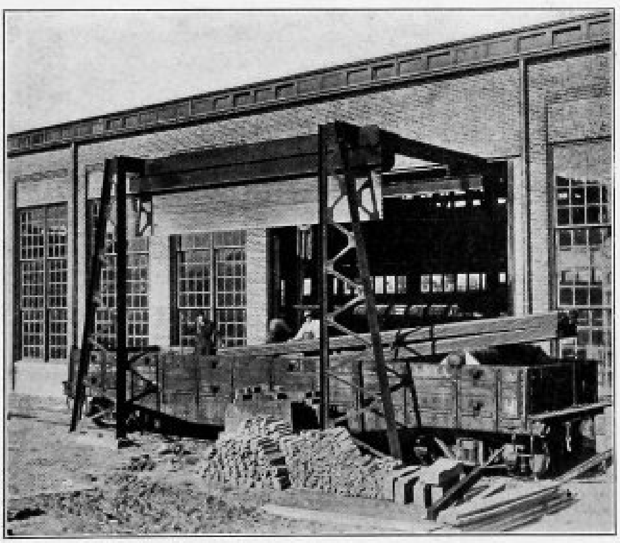


FIG. 3.—SPECIAL TRANSVERSE CRANEWAY FOR RECEIVING MATERIALS.

the opposite end, where the completed boilers are stored and shipped. Tubes, not being needed until boilers are assembled, are received and stored at this end. The whole floor area of both the main and flange shops is served by large or small traveling cranes, while a 24-inch gage Koppel industrial railway completely encircles the structure with connections in the interior, so that the handling of material of all kinds may be carried on with the least expenditure of time and energy. A roadway leads from Marcus avenue into the receiving end of the main building. A portion of the interior of this building is partitioned off for a machine shop to do the little work of that nature required in the manufacturing processes, and to care for the ordinary repairs and maintenance of the plant.

Three sources of power for the operation of the equipment are used, electric, hydraulic and pneumatic. All the generating machinery is located in the power house, which is placed in close proximity to the hydraulic and pneumatic tools, in order to reduce the length of the transmission lines, saving both in first cost, frictional losses and maintenance. The great majority of the tools are electric driven, by individual Wagner motors wherever practicable.

It is believed that the buildings as erected are amply large for some years of growth, so they are built with permanent ends, but, when conditions demand, the main shop may be extended toward the railway and the flange shop toward Marcus avenue. Also a wing or separate buildings can be built along the road end of the lot as an extension of the main shop.

As far as practicable all water is saved, to effect which a drainage system is provided, into which all rain water from the roofs as well as the clean waste from manufacturing processes is discharged. This system discharges into a large cement-lined cistern, 20 feet diameter by 20 feet deep, near the power house. As the only source of water supply is from the city mains, this arrangement effects a very appreciable economy.

The several buildings are all of the same general type, all structural details being standardized as far as practicable. At the outset it was determined to eliminate the fire hazard, and to build durably, and yet have a maximum of natural light in the interior, which meant large window space. Steel-frame structures, with outside walls of brick and reinforced concrete slab roofs, were accordingly adopted, with full-length monitors in the middle, in order to obtain additional light and ventilation. About 75 percent of the vertical areas exclusive of the retaining walls are glass. One size of window pane is used throughout, this being a commercial size, 12 inches by 16 inches. The advantage of this will be appreciated when it is understood there are over 22,000 panes in the several buildings. Wood is used only for window and door frames and doors, and the machine-shop floor.

CONSTRUCTION OF THE MAIN SHOP.

This building is 450 feet long by 143 feet wide for 250 feet of its length and 180 feet for the remaining 200 feet. It is of this latter part that the retaining walls form one side and end. The narrow portion is divided into three longitudinal bays, the middle one being 60 feet wide and the other two side ones 41½ feet. The increase to 180 feet is made by the addition of a fourth bay of 37 feet. The design of the steel frame follows standard practice, being calculated for the dead and live loads imposed by the roof and traveling cranes, the runways for which are 9-inch I-beams hung to the lower chords of the roof trusses, with the exception of the large craneway, which is carried directly on columns. The roof trusses are spaced 12½ feet centers, carried on the columns forming the bays. The columns of the central bay are spaced 25 feet centers longitudinally, 60 feet transversely, and carry the 25-ton traveling craneway. The spacing of the trusses thus provides stiffeners at the center points of the main crane runway and provides spans of only 12½ feet for the support of the smaller runways in the side bays. The roof of the middle bay is 14 feet higher than that of the side bays, thus forming the monitor in which the principal crane runs (Fig. 2). About the middle of the side, toward the power house, is the riveting tower, 100 feet long by 24 feet wide, its roof being 55 feet above the floor. The steel work of this tower is framed into that of the building proper.

The outside walls are of brick with concrete footings, and completely enclose the outer steel columns. The outside columns carrying the trusses of the fourth bay rest on the retaining wall, which also serves as a foundation for the brick walls that close the end and side of the building at these points. Practically all the windows in the walls are 9 feet 8 inches wide by 17 feet 5 inches in height, this being the standard size for all buildings. The stone sills of the windows are 3 feet 2 inches above the floor line, while the tops are practically at the height of the lower chords of the roof trusses. Each of these openings have two vertical rows of three sashes, each 3 feet 5 inches by 5 feet 10 inches high, and of the same construction. The middle sash is stationary; the upper and lower sashes are arranged so that they can be raised and lowered vertically. They counterbalance each other through steel chains over special pulleys at the top of the window frames, so that by raising the lower sash any degree of opening of the windows from nothing to two-thirds is very easily and conveniently accomplished by one man, and from the floor level. The windows over the retaining wall at the rear end and side are arranged so as to utilize as much of the space between the top of the wall and the roof trusses as is practicable.

Both sides of the monitor are practically all window space, there being two rows of sashes which are each 3 feet 5 inches by 5 feet 10 inches in size. The lower row of sashes is stationary; the upper row being pivoted at the middle so they can be opened for ventilating purposes. One side of this monitor is unbroken, but the opposite side is divided into two sections by the riveting tower. Double rows of windows arranged similarly to those in the monitor are placed in both sides and end of the tower. All the pivoted windows in the unbroken side of the monitor are operated in two sections of equal length, each by means of a single Lovell window-operating device. The two sections on the opposite side are each operated by a single device of the same type. The upper rows of sash on two sides of the riveting tower are likewise pivoted and operated (Fig. 1).

The standard size of door opening is 9 feet 8 inches by 18 feet high, closed by two equal swinging doors, one of which contains a small door to permit employees to pass easily into and out of the building. Above these doors are two stationary window sashes of the standard size. In the receiving end is located a special door opening, 22 feet 2 inches wide by 20 feet high. Through this is carried a transverse

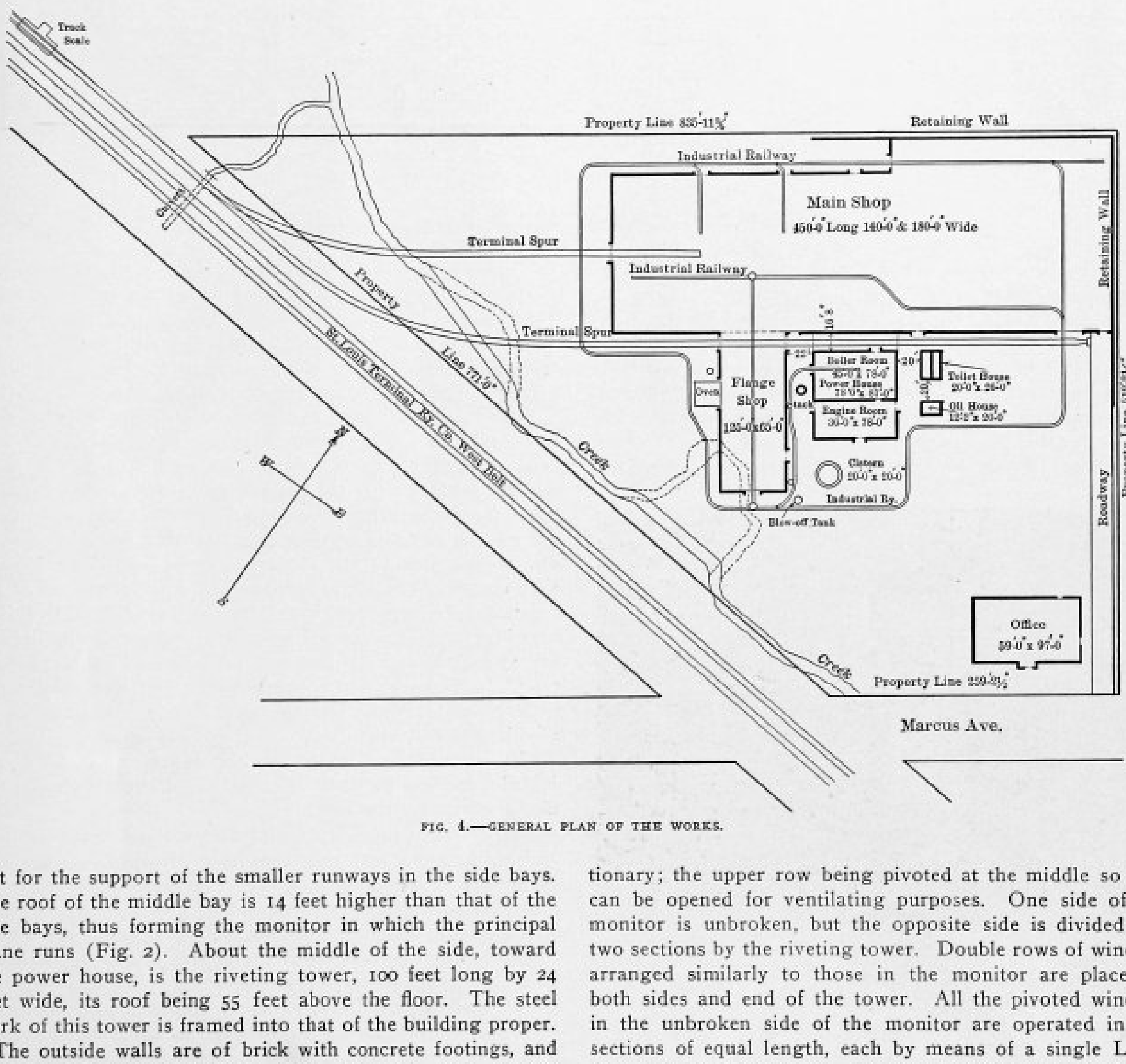


FIG. 4.—GENERAL PLAN OF THE WORKS.

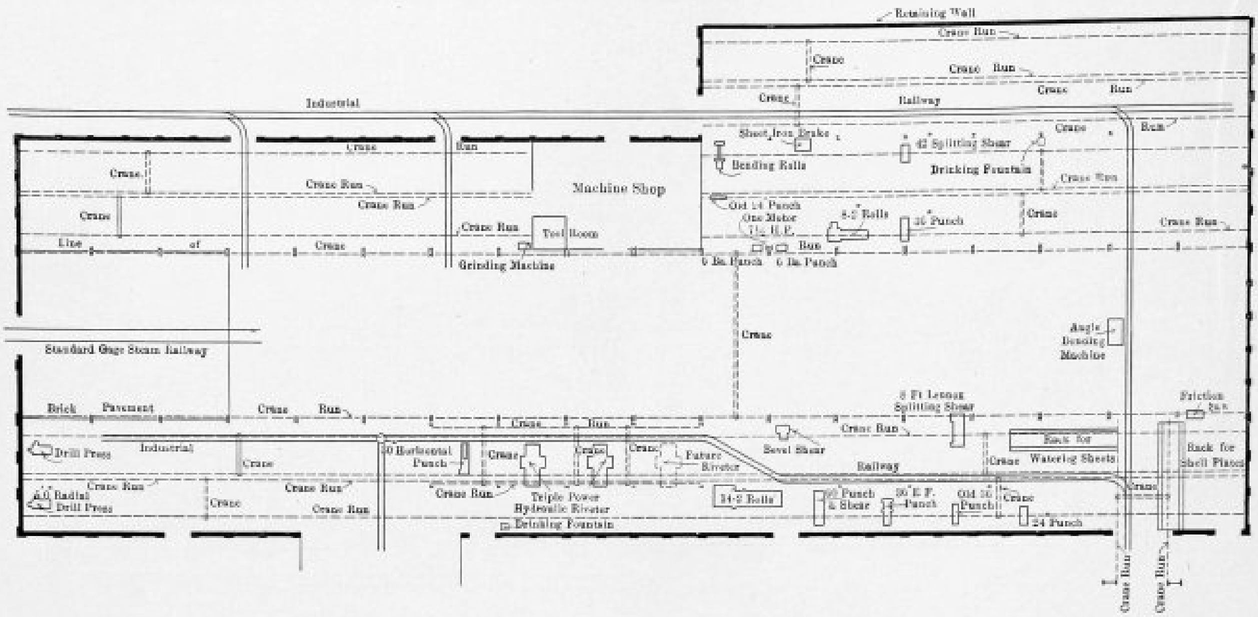


FIG. 5.—PLAN OF MAIN SHOP, SHOWING LOCATION OF TOOLS, CRANEWAYS, ETC.

craneway 18 feet 8¼ inches span projecting outside the building over the receiving track; the outer end being carried by "A" frames (Fig. 3). This connects with the longitudinal cranes on the inside, thus permitting the unloading of material from cars expeditiously and cheaply. This large opening is closed by means of a special variety rolling steel door carried on trolleys which run on the craneway. The carriage for this door is covered with a hood, which entirely closes the opening above and between the beams when

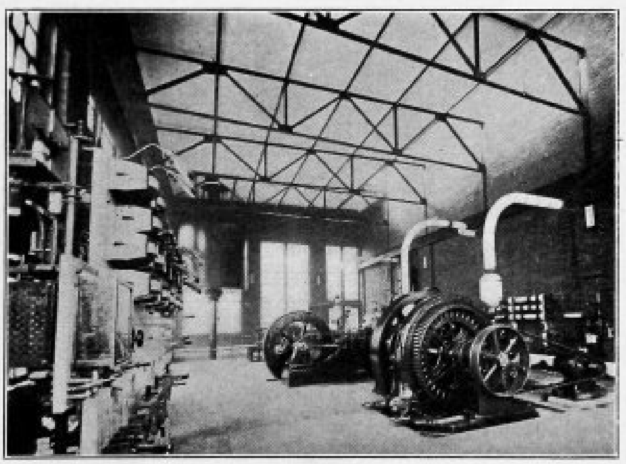


FIG. 6.—INTERIOR OF THE POWER PLANT.

against the building, the door and its rolling mechanism being suspended below the craneway beams. When in this position the rolling door lowers into the guides provided at the sides of the openings, and when it is entirely rolled up the whole carriage may be moved to the outer end of the craneway; thus giving an unobstructed passage for the traveling crane and at the same time preserving the continuity of the craneway. This special door was made necessary because of the extreme size of the opening and by the governing conditions which rendered any other type of door impracticable. The door and carriage are operated by means of gears and hand chains. The hood so protects the mechanism of the carriage and the door when it is rolled up that it can be left exposed at the outer end of the craneway without harmful results. Although the door is of large dimensions, it can be opened and closed by one man even in a high wind.

A door 14 feet by 16 feet high is provided in the end of the fourth bay to permit the placing of cars inside the building when the proposed switch on that side is put in.

The roof is a 2½-inch concrete slab, re-enforced with wire mesh and carried by 6-inch I-beam purlins placed five feet centers on the top chords of the roof trusses. This is covered with two-ply tar felt and gravel laid in hot asphalt. Two transverse expansion joints, dividing the roof into three equal sections 150 feet long, provide for changes in dimensions due to temperature. These joints are flashed with copper. The gutter troughs and downspouts are of 16-ounce copper, supported by 5-8 inch by 1½ inches galvanized iron brackets set in the brick work. Ample expansion joints are provided in the troughs to prevent buckling or breakages. Each downspout connects with a cast-iron shoe to the underground drainage system, so that rain water acts as an auxiliary water supply.

The exposed sides of the riveting tower are 4-inch re-enforced concrete slabs to the height of the monitor roof, above which are the windows.

The machine shop is formed by partitioning off a space 40 feet by 62 feet, with corrugated iron attached to angle iron frames fastened to the building columns. This partition, however, is largely window space.

Where the flange shop joins the main building the wall has been omitted, giving free communication between the two.

The floor will ultimately be of cinders, with a heavy residuum of oil binder and compacted by rolling. At present it is the natural clay. As before stated the machine shop has a heavy plank floor. The shipping track at the front end enters through a sliding door, 14 feet by 16 feet, holds two cars inside the building and bisects the testing floor, which is a brick pavement, 62 feet by 76 feet, laid in cement on a concrete base, draining into four sewer inlets which connect with the drainage system, thus returning the testing water to the cistern.

CONSTRUCTION OF THE FLANGE SHOP.

This building is 62 feet 4 inches wide by 144 feet long, the construction being similar in every way to that of the main building to which it is connected, the end wall being omitted, so that the two structures are practically one. The steel frame consists of a row of columns in each side wall spaced 25 feet centers, and which carry the roof trusses. There are intermediate trusses spaced 12½ feet centers. These trusses span the entire width of the building, leaving the floor area unobstructed and carry two parallel traveling craneways of 9-inch I-beams, with 18-foot 8-inch span, hung from the bottom chords, below which there is a clear height of 20 feet. This building has a monitor 13 feet wide by 9 feet high, made of light frames supported in the middle of and by the roof trusses. The window arrangement is exactly the same as in the main building, except that the monitor has but one row of pivoted sashes on each side, operated by a Lovell device.

Door openings 16 feet 10 inches wide by 20 feet 9 inches high are placed in the side walls at the ends next the main building through which the receiving switch passes. These openings are closed by Kinnear rolling steel doors, so that cars can be operated through the building on this track.

In one side of the building an opening is left in the wall for the large heating furnace which is housed in a small steel frame structure, placed against and outside the wall.

One of the outer corners of the flange shop is over a fill and a part of the original creek bed. This made it necessary to carry concrete footings down 24 feet to bed rock. These footings are in the shape of concrete columns, carrying re-enforced concrete beams just below the floor level and which in turn carry the steel frame columns and the brick walls. A standard door is in the middle of the outer end.

THE POWER HOUSE.

This building is 75 feet wide by 79 feet long, being separated by a distance of 22 feet from the flange shop and 16 feet 10 inches from the main shop. In the main its construction is the same as that of the other two buildings (Fig. 6), the main difference being that it is divided into an engine room, 34 feet 7 inches wide, and boiler room 42 feet 11 inches wide by a brick wall, in which is located a row of columns carrying the abutting ends of the roof trusses. The monitor, 13 feet by 50 feet long, with windows similar to those heretofore described, is half over one room and half over the other, the partition wall extending to its roof. The middle row of columns and the outer row carry the runway of an over-head traveling crane serving the engine room. The roof is continued over the space between this and the main building, in order that coal cars may be unloaded without interference by the weather. The entire floor of this building is at the same level, made of concrete and provided with necessary pipe trenches, which are covered with iron plates. The outer wall of the boiler room is carried up solid to the coal holes, a height of 8 feet. The coal holes are opposite the boilers and are 3 feet high and 10 feet long, with heavy iron frames set in the brickwork and closed with iron doors. Above these coal holes is a row of windows.

THE TOILET AND WASH HOUSE.

This is located 16 feet 10 inches from the main shop and 20 feet from the power house, where it is accessible with a minimum loss of time (Fig. 4). It is a one-story brick building, 29 feet by 26 feet, with a concrete roof and floor and divided by a brick wall into two rooms about 9 feet wide, one of which contains ten wash-down closets and an iron enameled urinal, both with automatic flush; white enameled wash sinks with numerous hot and cold faucets are in other room.

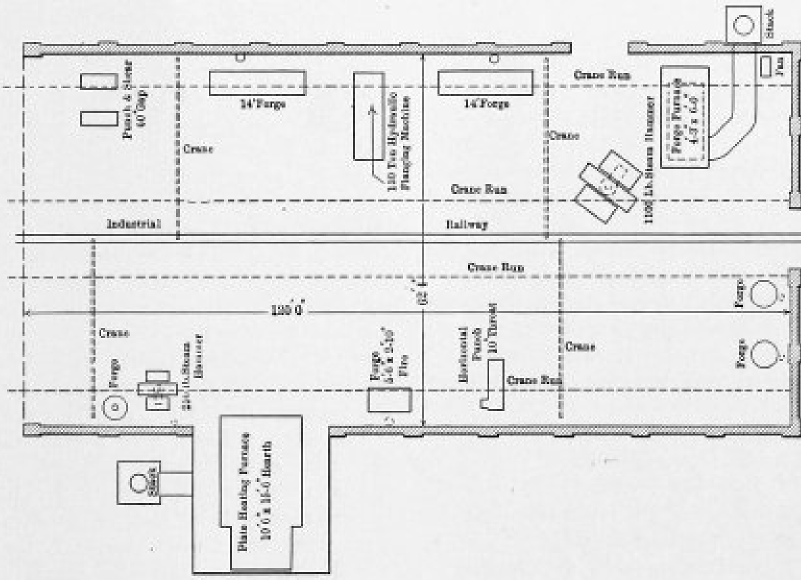


FIG. 7.—PLAN OF THE FLANGE SHOP.

A galvanized house boiler, heated by exhaust steam, furnishes a supply of hot water. Lighting is by small windows near the top of the walls. The sewage is carried by a sanitary sewer to the creek at the far corner of the lot.

THE OIL HOUSE.

This is a one-story brick building 12 feet by 20 feet, with a concrete roof and floor located 20 feet from the toilet house and 20 feet from the power house, from which it can be quickly reached. It is intended solely for the storage of inflammable liquids, etc. (Fig. 4).

EQUIPMENT OF THE MAIN SHOP, MACHINE SHOP AND FLANGE SHOP.

In this part are stored all the raw material, supplies, etc. Most of this storing is done at the extreme rear end and side, where there is the least light, yet where it is accessible and easily removed to any point where it may be needed. A three-ton Yale & Towne traveling crane on the transverse craneway heretofore mentioned serves the delivering track and places the boiler plate, which is the heaviest material received, directly into a series of racks that hold the plates in a vertical position, so that any plate may be withdrawn without unnecessary handling. The side bays are each served by four 3-ton 14-foot Curtis traveling cranes, with hand-operated triple blocks running on two adjacent parallel crane-ways in each bay, hung to the bottom chords of the roof trusses.

This shop contains tools as follows, arranged as shown by Fig. 5. The motor sizes given indicate that the machine is driven by an individual motor:

BOILER PLATE WORKING TOOLS.

One Ryerson high-speed friction saw, 30 horsepower motor.

One 24-inch Kraut punch, 7½ horsepower motor.

One 36-inch Long & Allstatter punch, 7½ horsepower motor.

One 36-inch Cleveland punch, 7½ horsepower motor.

One 8-foot Lennox splitting shears, 7½ horsepower motor.

One 60-inch Cleveland punch and shear, 10 horsepower motor.

One Lennox rotary bevel shear, 7½ horsepower motor.

One 14-foot Hilles & Jones bending roll, 10 horsepower and 30 horsepower motors.

Two 100-ton Woods triple power hydraulic riveters.

One 30-inch Long & Allstatter horizontal punch, 7½ horsepower motor.

The last three machines are located under the riveting tower and are served by three 10-ton Wood hydraulic tower traveling cranes, with 40-foot lift and 20-foot 7-inch span.

One unoccupied section in this tower provides for an additional riveter.

Two 5-foot radial drills belted from a shaft driven by a 10-horsepower motor, supported over-head on a bracket bolted to the wall.

One Wood portable hydraulic riveter, which is handled by the hydraulic hoist in the 30-inch horizontal punch tower.

One 25-ton .Pawling & Harnischfeger electric traveling crane, 26½-foot lift, 60-foot span, with 5-ton auxiliary hoist with General Electric motors for all movements.

An outfit of pneumatic calking, riveting and chipping hammers.

Also the following sheet-iron working tools:

One angle-bending roll, 10 horsepower motor.

One sheet-iron break, 7½ horsepower motor.

One 42-inch Lennox splitting shear, 7½ horsepower motor.

One 36-inch Kraut punch, 7½ horsepower motor.

One 8-foot Hilles & Jones bending roll, 10 horsepower motor.

Two 6-inch Cleveland punches belted to a counter shaft, driven by a 7½ horsepower motor.

One 6-foot Hilles & Jones bending roll.

One 24-inch Long & Allstatter punch.

These two latter are belted to a counter shaft driven by a 7½ horsepower motor.

The machine-shop equipment is mainly belt driven by a 20 horsepower motor through a line shaft. There are four lathes of various sizes, one shaper, one universal milling machine, three different sizes of radial drills, one planer, one heavy-duty motor-driven boring mill; one double-head bolt cutter, two pipe-threading machines, a combination grinder, one wet grinder.

In the flange shop are (Fig. 7):

One 180-ton 60-inch Wood hydraulic punch and shear.

One 150-ton 60-inch hydraulic sectional flanging machine.

One 1,100-pound Bement Niles steam hammer.

One 10-inch Long & Allstatter horizontal punch, 7½ horsepower motor.

One 250-pound Bement Niles steam hammer.

Two 2-foot 10-inch by 14-foot hearth, open-forge fires.

One 2-foot 10-inch by 14-foot hearth, open-forge fire.

One 4-foot 3-inch by 6-foot hearth reverberatory forge furnace.

One 10-foot 6-inch by 15-foot 6-inch hearth, reverberatory plate-heating furnace.

Three blacksmith forges.

One 24½-inch motor-driven blast pan and pipe connection to forges.

One cast-iron plate straightening bed and roller.

Complete set of cast iron forming blocks, dies, etc., to suit the special requirements of the type of boiler built by this company.

Four 3-ton Curtis traveling cranes.

All the small traveling cranes in both shops on adjacent parallel tracks overhang their runways far enough so they can be locked together and the trolley run from one to the other.

All the steam, hydraulic and air pipes and electric wires are brought over from the power house in covered trenches, and are so arranged that they can be easily drained in cold weather to avoid all danger of freezing. The air pipes have numerous connections at convenient points throughout the main shop, flange shop and machine shop.

EQUIPMENT OF THE POWER HOUSE.

The boiler plant consists of three Heine boilers of 250 horsepower each set separately. Two of them are provided with Heine superheaters of two different capacities. They are all fired by hand and have flat shaking grates. Back of the bridge walls of each furnace is a special firebrick wing-wall construction for the prevention of smoke, and which is claimed to accomplish the object very satisfactorily. The two boilers with the superheaters are set in brickwork in much the usual way. The third boiler has a concrete setting with firebrick lining. This was tried as an experiment to determine the availability of concrete construction for this purpose, and with the expectation that it will be more durable than brick and less liable to the cracking that all brick settings are subject to. The three boilers each differ from the others in dimensions, and all are arranged so that measurements and observations of all kinds may be conveniently made.

The company has in view a great variety of experiments to determine questions now in doubt and to develop further improvements in boiler practice. This will account for the boiler capacity being out of proportion to the rest of the plant. One boiler will easily carry the load. A straight horizontal sheet-iron breeching connects the boilers with the chimney located in the space between the boiler house and the flange shop. This is a re-enforced cement chimney, 66 inches inside diameter by 147 feet high, the foundation for which is 11 feet deep and 22 feet square at the base, a concrete monolith.

As the power requirements are not great, the installation of automatic stokers and coal and ash handling machinery was not deemed expedient. Coal is therefore unloaded by hand into the space in front of the boilers, which has a capacity of about two cars.

A Hoppes exhaust steam feed-water heater, with a capacity of 15,000 pounds of water per hour, is placed on an iron support against the division wall. The air supply for the compressor is brought from the roof through a 12-inch sheet-iron duct to an air washer placed behind the boilers. A small duplex steam pump delivers water from the cistern to the heater, being regulated by a Fisher governor. A boiler tester of the injector type supplies hot water under the required pressure for the hydrostatic test applied to all boilers before shipment. This testing can also be done by pressure from the hydraulic system, and through proper connections by the boiler feed pumps. An injector for feeding the boilers is provided for the use of the night watchman, in order to avoid running the pumps.

All hot piping and the smoke flue are heavily covered with

2-inch 85 percent magnesium. Two openings, 3 feet wide and 7 feet high, are the only inside communications between the boiler and engine room, and are closed by sliding wooden doors covered with sheet iron. One end of the boiler room serves as a work shop and has an enclosed dressing room and toilet.

The electrical energy is developed by a 162 horsepower four-valve non-condensing Ball engine, 13 inches by 18 feet, running 200 revolutions per minute. A 100-kilowatt 220-volt three-phase 60-cycle Western Electric Company's generator is directly connected to the engine. A 11-kilowatt exciter is belted to a pulley on the engine shaft. The voltage is maintained constant by a Tirrell regulator mounted on the switchboard. All wires in the engine room are placed in conduits under the floor. The switch board is completely equipped with all the measuring, controlling and distributing devices, and is divided into four panels; one for the generator, all current delivered being measured by a watt meter; two for the four power circuits; one for the six lighting circuits.

A Laidlaw-Dunn-Gordon two-stage compound non-condensing air compressor is next to the engine. It has 12½-inch and 22-inch steam and 22½-inch and 14-inch air cylinders, with 18-inch stroke. Its capacity is 1,200 cubic feet of free air per minute at 100 pounds pressure when running at 145 revolutions per minute 145 pounds steam pressure. It takes its supply from the air washer just the other side of the partition, and discharges into a receiving tank, 36 inches by 10 feet, standing near by.

A Worthington duplex-compound non-condensing pumping engine, with 14-inch and 22-inch diameter steam and 4-inch diameter water cylinders, 18-inch stroke, supplies the hydraulic system. Its capacity is 100 gallons per minute, against 1,500 pounds pressure, with 145 pounds steam pressure. A Wood hydraulic accumulator, 12-inch diameter of ram and 15-foot stroke, loaded to give 1,500 pounds pressure per square inch, is located in one corner of the room. It is connected with an automatic controlling valve, which shuts off the pump when the limit of lift is reached.

A 700-cubic foot Norwalk air compressor, an old machine from the old shop, is located next the larger machine, and is connected to the same supply and discharge, but is intended only for emergency use.

There is additional space in the engine room for a duplicate generating set, and also for another 1,500-pound hydraulic pump.

Two 7½-inch by 4-inch by 8-inch Blake duplex outside-packed plunger feed pumps are placed against the partition opposite the heater, and are controlled by Fisher governors. The feed piping is in duplicate and so arranged that any boiler can be fed independently of the others and of the other pump. This is to permit the testing of any boiler without interfering in any way with the operation of the plant. The suctions of these pumps are connected to the heater, the city mains and the cistern. Means are provided for filling boilers directly with city water. The small pumps have a separate steam header, so as to be independent of the main steam headers.

A 10-ton Pawling & Harnischfeger hand-power traveling crane, with 33½-foot span and 17½-foot lift serves the entire area of the engine room. Only the live steam pipes are exposed in this room, all others being laid in covered trenches.

LIGHTING, HEATING AND VENTILATING, ETC.

Artificial lighting is mainly by ten flaring arc lights, uniformly distributed through the shops. They are hung to clear the cranes in monitor and bays, and in the latter are about 22 feet from the ground. The engine and boiler room have each one lamp of the same kind. In addition each machine tool has one or more incandescent lights near the workman. Special six-light incandescent fixtures are recessed in the walls ten feet from the floor around the sides of both engine and boiler rooms, with switches in closed hand-high pockets. The water and steam gage of the boilers each has a light on separate circuits for each boiler. No outside current is used for either lights or power, except for two arc lights for night use and for the office.

A boiler shop requires heating only in comparatively cold weather, say when the temperature falls below 45 degrees or 50 degrees Fahrenheit. It is therefore unnecessary to heat it above that temperature at any time. Open salamanders, usually without means for carrying off the gases of combustion, is the plan most often used, but a better plan from every point of view has here been adopted. The main shop is provided with a sort of hot-blast system, consisting of five sets of enclosed coils of ¾-inch pipe, each containing about 2,000 square feet of radiating surface. A motor driven-fan forces the air through the coils discharging directly into the room in an opposite direction from the intake. These sets are distributed so as to give the greatest heating effect where needed. It is anticipated that the circulation thus created will be sufficient to make the temperature sufficiently high and as nearly uniform as is necessary. Exhaust steam is used, but whether there will be sufficient or not, and whether the system will be satisfactory, has yet to be determined. The machine shop and toilet house and office are heated by direct radiators. The flange shop needs no special heating, the fires there being ample. If there proves to be insufficient exhaust steam, live steam will be turned in through a reducing valve, provision for this having been made.

To provide cool drinking water in summer a special drinking fountain was designed, of which two are installed. This consists of a concrete-lined pit, about 4 feet by 6 feet by 3 feet deep, divided into two compartments, one 27 inches by 27 inches, the other 18 inches by 37 inches. The walls of the larger, which is the ice chamber, are built with air spaces. Near the bottom is a horizontal coil of 1½-inch galvanized pipe, with a wooden grating above to hold the ice. A drain, the bottom of which is 2 inches above the top of the coil, carries the warm water into the other compartment, in which are the valves for shutting off the supply, etc., and from which all waste is drained into the drainage system leading to the cistern. Over this latter compartment is the hydrant, with a suitable waste pipe and perforated cover. About 300 pounds of ice can be put in the chamber, which is covered with both a thick wooden and an iron lid. In hot weather the supply of ice lasts two days. Water from the city mains is used exclusively for drinking.

Although the buildings are free from fire risk to such an extent that it is considered unnecessary to carry insurance, there is more or less inflammable material around in the shape of boxes, barrels and other packing material, as well as wooden railway cars. A simple fire system was therefore installed. Six 2-inch fire hydrants are uniformly distributed through the main shop, with 100 feet of canvas hose and nozzle suspended on holders at each. There are also three hydrants outside, two on opposite sides of the front end of the main building and one near the oil house. The water supply is from the city mains and under a pressure of 60 pounds, so no other source of supply for this purpose is necessary. In addition there are nine Minamax non-freezing and twenty-four Johns-Manville dry-powder fire extinguishers hung at numerous convenient points. This system is supplemented by a city fire-alarm box on the outside of the power house.

COSTS.

The land was purchased in the middle of 1907 and the general scheme worked out by the officers of the company in conjunction with Messrs. Lichter & Jens, consulting engineers, who drew the plans and superintended the work. Much of the preparatory draughting work was done prior to the time when the decision was reached to proceed with the building of the plant.

The actual construction was purposely undertaken at a time of business depression. So far as prospects for obtaining sufficient orders to anywhere near develop the capacity of the plant when completed or soon thereafter were concerened, there was little incentive to proceed. Owing, however, to the very limited building operations of this nature throughout the country at the time, it was certain that the first cost would be very low. Early in 1908, when materials were at their lowest prices, it was therefore determined to proceed, financial arrangements having been satisfactorily concluded.

The grading was done in June, and July, 1908. A little more then 18,000 cubic yards of earth was excavated at a cost of 16 cents per yard.

This and the retaining wall were executed by The Fruin & Colnon Contracting Company.

The steel work, amounting to about 790 tons, was furnished by the Riter Conley Manufacturing Company, at the rate of practically 2.6 cents per pound f. o. b. St. Louis. It was all inspected by the R. W. Hunt Bureau of Inspections and Tests before leaving the factory.

The erecting of the steel was done by the Midland Erection Company at the rate of $8.80 per ton. The general contract for the completion of the main shop, flange shop and power house was executed by the Fruin-Colnon Contracting Company.

The total cost of these buildings was $1.15 per square foot of floor area excluding the retaining walls and grading, and $1.29 including those two items. This of course does not include any of the equipment.

[EDITOR'S NOTE:—The foregoing description of the new shops of the Heine Safety Boiler Company, at St. Louis, Mo., is from a paper read by Mr. E. R. Fish at a joint meeting of the Engineers' Club, of St. Louis, and the St. Louis Section of the American Society of Mechanical Engineers, Nov. 13, 1909.]

Rear Head Handhole Plates.

The rear handhole plate, or rather the crowfoot and bolt, generally gives an engineer considerable trouble by burning off; and when it has to be taken out it is a case either of twisting it off or else the nut has to be split with a hammer and cold chisel.

I once worked for a chief engineer who did not believe in following in the footsteps of another man, if he could think of any way of doing a thing in what he considered a better way. As the boilers had to be opened up for cleaning and washing quite frequently, and as there was always a lot of trouble with the rear handhole plate studs and nuts, he came to the conclusion that a bolt and nut was not just the thing for that place. No matter how carefully we might cover up the crowfoot and bolt with fireclay, it would crack off and the bolt and nut would be more or less burned and welded together.

He had some plates made with a bolt in which a slot was cut about ¼ inch wide and 2 inches long, and some taper keys made to fit. When putting in the plate the crowfoot was slipped on the bolt, the key inserted in the slot and driven down good and hard, and it was tight, with none of the twisting or turning of the plate in the hole where the nut has a tendency to turn the least bit hard on the bolt.

This twisting of the plate is one great cause of leaky handhole plates. Even when plenty of care is taken to get them in straight, as in tightening up, if the nut works the least bit hard, it will turn the plate out of place in the hole.

We got an old tomato can large enough to go over the crowfoot, and cut slots top and bottom to allow it to go by the key, cutting out the tin in the slot where the key would come, so that when the can was in place the remainder could be bent back of the key to hold the can in place. We filled the can with a mixture of fireclay and old asbestos pipe covering, broken up fine and mixed with water, so that it would be fairly stiff. It was put on over the bolt and crowfoot, the tin bent back in place and by the time the can had become burnt the mixture was baked hard enough so that it would not crack off.

This arrangement filled the bill, and as far as I could see, was just as good and strong as the bolt and nut, and gave no trouble to remove. If by any chance the covering came off and the key burnt off down to the bolt, a minute's work with a hammer and cold chisel would chip it off smooth, so that the crowfoot would slip off the bolt with ease.

Now that boilers 60 inches and over in diameter are required to have a manhole in the front head below the tubes, I cannot see any need of a handhole in the rear head. What do the rest of the readers think about it?—W. E. S. in *The National Engineer*.

Energy in a Steam Boiler.

Most of the energy in a steam boiler under pressure is contained in the water, and only a relatively small amount of the energy in the steam. Take, for instance, the case of a horizontal tubular boiler carrying 150 pounds pressure and having 160 cubic feet of water space and 80 cubic feet of steam space. The water weighs $160 \times 62.4 = 9{,}984$ pounds, and the steam weighs $80 \times .3671 = 29.37$ pounds. The energy in each pound of water at 150 pounds pressure that would be liberated by explosion and expansion down to 212 degrees F. is 11,823.4 foot-pounds, and the energy in each pound of steam at the same pressure is 134,521.2 foot-pounds (*A Manual of Steam Boilers*, by Prof. R. H. Thurston, table entitled "Total Available Energy in Water and Steam"). The total energy in the water is therefore $9{,}984 \times 11{,}823 = 118{,}040{,}832$ foot-pounds, and the total energy in the steam is $29.37 \times 134{,}521 = 3{,}950{,}882$ foot-pounds. The energy in the steam is consequently less than 4 percent of that in the water. The water is the more dangerous content of the boiler. The total energy in the water and steam is $118{,}040{,}832 + 3{,}950{,}882 = 121{,}991{,}714$ foot-pounds. If the boiler weighs, say, 10,000 pounds, and if all of this energy were expended in an explosion in projecting the boiler vertically, then, neglecting the friction of the air, the boiler would rise to a height of 12,199 feet, or over 2 miles.

The secret of avoiding boiler explosions is regular inspections at short intervals by competent men, and prompt compliance with their recommendations in regard to repairs and the allowable working pressure. Prof. Thurston concluded that but one boiler in 10,000 explodes among those that are insured and periodically inspected, and that the proportion is ten times as great among those uninsured and uninspected.—*The Fidelity and Casualty Company, of New York.*

The prevention of boiler explosions, no less than of the slighter accidents, depends upon the proper design, construction and operation of the steam plant throughout. In order to ensure proper design and construction the best procedure is to have the plant erected under the supervision of a capable mechanical engineer. Serious mistakes will then be avoided.

BOILER PRACTICE IN GREAT BRITAIN.

In our October issue we published a summary of a recent report to the International Railway Congress on the subject of locomotive boiler practice in Belgium, Spain, France, Italy and Portugal. The following is a summary of a second report to this body covering the subject of improvement in locomotive boilers in Great Britain, India, South Africa and Australia:

Probably the greatest change in boiler construction which has taken place in recent years on the administrations reported upon is the largely increased use of Belpaire fire-boxes, the majority of newly-designed engines having been provided with this type. One great advantage derived from this change is that the disuse of roof bars leaves the space over the top of the fire-box clearer and more easily washed out, and some of the administrations who have not adopted the Belpaire box have in their later boilers fitted radial stays with the same object in view. There seems to be less trouble with a copper tube plate when fitted in a Belpaire than in a round-topped box, but this point is perhaps open to question. A few of the administrations employ wide, comparatively short, fire-boxes, which are placed over the frames, and the Great Northern Railway of England is getting particularly good results with this type. It readily allows a large grate area and facilitates the renewal of any defective stays, but with passenger engines, at all events, entails a small uncoupled trailing wheel. The weight of the engine, as a whole, has an important bearing upon the design of the boiler, for in order to keep the load per wheel down it has frequently been found necessary to slope the door plate forward, so as to prevent the load per unit of area on the trailing journals becoming too great, and this in spite of the fact that these bearings are sometimes as much as 10 inches in length and 8¾ inches in diameter.

In spite of its high, and at times excessive price, copper is still very generally used for fire-boxes on the railways reported upon, and no consistently good results seem to have been obtained with any other material, although one or two administrations use steel for goods or secondary engines which are not heavily worked. It is interesting to note that, although two administrations have tried cylindrical steel fire-boxes, they have not extended their use. This seems largely due to the difficulty of raising steam in them, owing to the poor circulation due to a considerable body of the water in the boiler being below the source of heat, and therefore not affected by the convection currents set up. One of the reasons for the abandonment of steel fire-boxes has been the trouble from corrosion, and to endeavor to meet this nickel-steel has been experimented with, but up to the present has not been found satisfactory.

The advantages of employing high-pressure steam are becoming more and more realized, and a number of administrations use 200 pounds per square inch, while with two it rises to 220 and 225 pounds. In one of the latter they employ it in compound engines, while the other, on which the engines are simple expansion, use the highest pressures met with, viz.: 225 pounds. These higher pressures, as might be anticipated, tend to accentuate boiler troubles, and render more imperative the employment of good water and the selection of tubes and longitudinal stays which will not cause excessive distortion of the tube-plate. Some administrations have found that the troubles associated with higher pressures have not been compensated for by the advantages gained, and have returned to a lower maximum. The question of weldless barrel plates is of considerable importance, and a large firm of steel makers in Sheffield have put down an extensive plant for the manufacture of these plates, which are being tried by one administration, at least in England.

On the whole, the proportion of steel and iron tubes to copper and brass is growing, and several of the British administrations have wholly dispensed with the latter expensive metals. In India, brass is very extensively used, and pitting just inside the ferrule, due to mechanical action from the coal, does not seem to give the trouble it does on some lines. As might be expected, steel and iron are much more liable to corrosion than the other metals, especially near the fire-box, and nearly all who use these materials arrange for the renewal of this end of the tube when the corrosion has rendered it unfit for further use. Copper ends and sleeves are occasionally employed to prevent this defect.

Considerable attention is now paid to the expansion of the tube into the tube-plate, this being generally carried out by mechanical means. Attention has also been given to the order of expanding, various procedures being adopted to prevent, as far as possible, the distortion of the tube-plate, caused by the work put on it during expansion. Opinions are still divided as to the relative merits of the arrangement of tubes in vertical or horizontal rows, but the former seems to be gaining ground, as it keeps the boiler cleaner, allows steam to rise more readily when working, and scale to fall more freely during washing out.

Attention is being given in many quarters to the better regulation of the admission of air to the fire, and this should lead to improvement in the maintenance of the fire-box tubeplates; no full particulars are, however, yet available. The question of a forced draft on the "plenum" principle is also being considered, but nothing practical has yet been evolved, and, although such a system would effect a great improvement, the quantity of air to be admitted with an express engine is very great, rising in some cases to at least 8,000 cubic feet per minute. The increase of pressure and harder work to which modern boilers are subjected, has led to more attention being paid to the arrangement and spacing of tubes and stays, especially with a view of giving greater flexibility at the corners where cracking usually takes place. Although "extended" smoke-boxes are only used by a few of the administrations, yet there is an increasing tendency to enlarge these boxes, with a view to equalizing the "draw" through the tubes and preventing, to a certain extent, the ejection of sparks.

Little has been done with regard to watertube boilers, and the use of watertubes in the fire-box of the Drummond type has not met with general favor; but, in addition to the cases mentioned in the report, it is understood that the Japanese State Railways are adopting these watertubes to a certain extent. At the time of writing, there are only two administrations in the countries reported on which are using superheaters to any large extent. There are, however, a number of others who are experimenting with this type of engine, and it is probable that their use in the countries dealt with will shortly be considerably extended.

The practice of the different administrations in regard to water softening varies greatly, some having adopted it extensively and others practically neglecting it. The softeners in use include the following: Archbutt-Deeley, Desrumaux, Kennicott, Pulsometer, Reisert, Porter-Clark and Wollaston. In one case, Mirrlees-Watson Yaryan Distillers are used. The chemicals used in softening are invariably lime and soda. When the proportion of soluble salts in the concentrated boiler water reaches from about 214 to 500 parts per 100,000 (150 to 350 grains per gallon), the amount varying with the type of boiler, rate of steaming and nature of the salts, foaming of the water is sufficient to cause serious priming, and for this reason it is found necessary to limit the amount of soda used in softening. To overcome this difficulty, some railways have tried barium compounds in place of soda or soda-ash in softening, but the cost has always been found to be prohibitive; in fact, with some waters it may be as cheap, or cheaper, to distil the water, and thereby remove all impurities as to soften with barium salts.

The experience of those railways which have adopted water-softening shows that great saving is effected thereby in the cost of retubing boilers, replacing broken stays and removing scale, while leakage is practically stopped. Two administrations record a large saving by being able to soften and use water which can be obtained cheaply, instead of purchasing expensive water of better quality. Since the date of the last report (1900) the use of water-softening plants has considerably extended among the railways reported on, and there is no doubt but that it will continue to extend as the saving which is capable of being thus effected becomes better realized. One reason why progress in the past has been slow, is the fact that water softeners were regarded as machines which required no scientific control and could be efficiently run by the laborer in charge. Most railways now employ chemists, and it is realized that the water softeners should be placed under the supervision of the chemical as well as of the engineering staff. Those railways which have been working on these lines find that the results obtained well repay the cost entailed by water softening. To obtain the best results, water softening should be used in conjunction with a system of changing the water in the boilers before it has become too concentrated in regard to sodium salts, or saturated as regards that part of the calcium sulphate which cannot be economically removed without unduly charging the water with sodium salts. To enable the water to be changed with the necessary frequency, and without engines spending too much time in the shed, the boilers must be filled up with hot water. When the amount of sodium salts or calcium sulphate in the original water is excessive, undue concentration can only be prevented by the use of blow-off or scum-cocks of some description. The practice adopted must be based upon and controlled by a systematic chemical analysis of the principal waters used by the locomotives in each district.

Disincrustants are used in the boilers by a few railways; those most commonly employed being preparations containing tannin or soda alone, or a mixture of the two. The experience of some administrations has been unfavorable, others have given up the use of disincrustants in favor of water softening. Several railways have contributed analyses of specially corrosive waters, the results of which are given in the body of the report. For the prevention of corrosion, some railways obtain good results by coating the boiler plates with Portland cement; but in one case it was found that in the boilers in which this was used it washed off and was a failure. A coating of graphite and boiled linseed oil has been tried, but was found to percolate through the seams and joints and cause leakage. On one line the boilers are painted inside with tar and graphite. Zinc plates and plugs have been tried by several railways with unsatisfactory results. Some administrations have found the addition of a definite excess of slaked lime to the water distinctly advantageous in preventing corrosion, especially in the case of natural soft waters. The majority of the railways still use cold water for washing out boilers, but the use of hot water is extending. On many lines the use of blow-off cocks or scum-cocks to prevent priming is necessitated by the bad quality of the water which has to be used.

There seem to be no special features in the replies to questions on cracks, pitting, grooving and general surface corrosion, as all the administrations suffer more or less from these defects in much the same manner and in the same position in the boilers. Although various steps have been taken to prevent these troubles, none seem to be universally satisfactory. Efforts are being made to increase the water spaces around the sides of the fire-box to prevent breakage of stays and corrosion of fire-box plates; to give larger radii at corners and prevent the tubes from coming into close proximity to the edge of the tube-plate to lessen the chance of cracking, etc., and these doubtless help to minimize the troubles; while water-softening and mechanical cleaners also help in this direction. Practically two, and only two, types of material are employed for boiler stays, viz.: copper and bronze (Stone's), containing copper with nickel, manganese and iron. The latter material is stronger at boiler temperatures than copper, but the head of the bronze stays tends to burn off more readily than copper, and some administrations state that the heads are liable to break off in the fire-box plate. There does not seem to be a great deal of trouble with stays fracturing, except at the top front corner of the fire-box, and even here the trouble is not marked enough to cause the special flexible stays, as used in America, to be adopted.

ON THE NUMBER OF COURSES IN A BOILER SHELL.*

Prominent among the many problems that arise in designing a steam boiler is that of the construction of the shell. We do not here refer to the way in which the parts should be riveted together, but to the more elementary question of how many parts there should be.

In nearly all of the horizontal tubular boilers that are now met with in practice, the shell is composed of a certain number

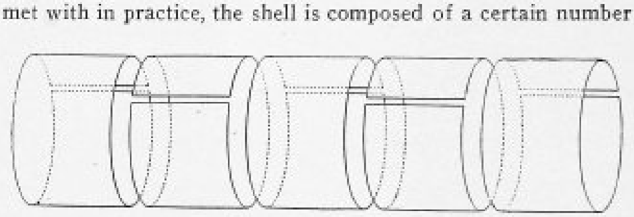


FIG. 1.—FIVE-COURSE SHELL.

of "rings" or "courses," each course consisting of a cylindrical section, composed usually of a single plate, curved around so that its two ends meet and are riveted together. It was formerly the custom to have more courses in the shell than are now common, because the plate mills were not equipped to turn out sheets of the large size that may be had at the present time. Thus it was usual, in a boiler, say, 60 inches in diameter and 16 feet long, to build the shell in five courses, as will be understood from Fig. 1, which represents the several courses

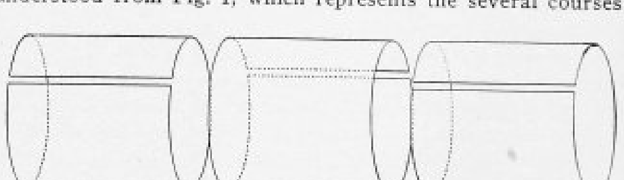


FIG. 2.—THREE-COURSE SHELL.

as they would appear when rolled approximately into shape but not yet riveted together.

As the rolling mills came to put in larger and heavier machinery, so that plates of much greater size could be turned out, the number of sections in the shell was reduced, and boilers presently came to be built in three coures, as indicated in Fig. 2. (The "three-course" boiler, we may say in passing, is the one that is still favored by this company, for reasons given below.)

If we should continue to reduce the number of courses, we should be led, ultimately, to a "one-course" boiler, as indicated in Fig. 3. Small shells, for tanks and drums and the like, have long been made in this way, and for such structures the one-sheet design is excellent. Sheets of enormous size would be required, however, if we were to build large boiler shells in one course, according to the scheme of Fig. 3. Thus, for a shell 16 feet long and 60 inches in diameter, we should have

* From *The Locomotive.*

to have a sheet about 16 feet square. Sheets of this size would be expensive, even if they could be produced commercially, and of a satisfactory quality, and the difficulty of transporting them would practically make it necessary to roll up the shell where the plate was made. Moreover, other and far more serious objections can be urged against building large shells of single sheets, as will appear from the later portion of this article.

As a compromise between the enormous sheet that would be required in making a large boiler according to the plan shown in Fig. 3, and the smaller ones that are used when the shell is built in several courses, we might use the method suggested in Fig. 4, where the shell consists of two sections, each extending the entire length of the boiler. The two sheets need not be of identically the same size, and it would, in fact, be better, if this construction were to be adopted, to make the bottom one somewhat wider than the top one, so that the riveted joints could be kept high enough to be beyond the influence of the hot furnace gases. The objections that can be urged against the construction shown in Fig. 3 apply also, however, to that shown in Fig. 4, save that the sheets in Fig. 4, being smaller, would be easier to transport, and would also be somewhat cheaper, pound for pound.

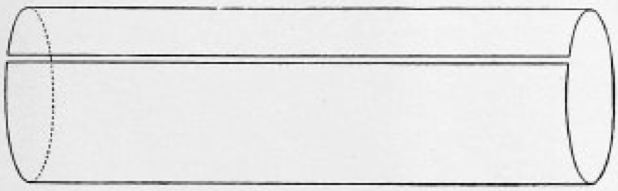


FIG. 3.—ONE-COURSE SHELL.

A few years ago it was common for boiler makers to favor the plan of construction suggested in Fig. 5. Here, as will be seen, the bottom part of the boiler is composed of a single sheet, while the top part is composed of two or three smaller ones. This is known as the "single-bottom sheet" design, and at the time it was introduced it was hailed by many as a great advance in boiler construction, inasmuch as a smooth and uniform surface was presented to the furnace gases, and no girth joints were exposed to the direct heat of the furnace except at the very end of the shell, where the rear head was attached. The Hartford Steam Boiler Inspection & Insurance Company, however, never favored this construction, and never made a specification for a boiler of this kind. We discouraged the use of the type from the first, thereby subjecting ourselves to no little criticism from those who fancied themselves to be more "progressive," and considered us to be "ultra-conservative," or worse. Experience has shown, however, that we were correct in our view, and it is now pretty generally admitted that "single-bottom sheet" boilers are short-lived, and that their apparent advantages are illusory. Many of the shops that formerly built them, build them no longer, and we shall soon be able to speak of the type as obsolete. We have accepted such boilers for insurance, when inspection indicated them to be in safe condition. We have always watched them with especial care, however, and we have nevertheless suffered severe losses from them on quite a number of occasions.

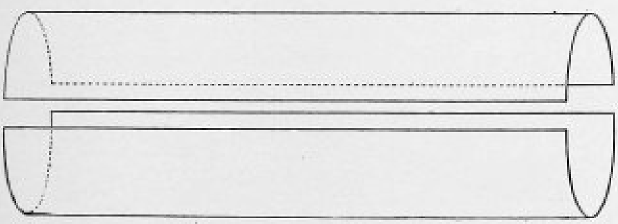


FIG. 4.—DOUBLE, LONG-SHEET SHELL.

Our inspectors have frequently detected fractures along the long joints before failure actually occurred; and we feel that we can say with confidence that the number of bad explosions that would otherwise have to be charged up against this type of boiler has been kept down in considerable measure by our inspection service. The terrible explosion at the plant of the Penberthy Injector Company, at Detroit, in 1902, is an example typical of the many violent explosions that have occurred, with great loss of life and property damage, in boilers having the single-bottom sheet.

The explosions that have been experienced with the single-bottom sheet boiler have been mainly due, we believe, to the fact that the long joint was not "broken," and to the added but closely related fact that the shell was not stiffened as it is when girth joints are present. The adoption of the long horizontal seams in these boilers was an undoubted mistake, since a shell so made is considerably weaker than one in which the longitudinal joints are broken up into three lengths that are separated from one another as they are in the three-course boilers that we design. Moreover, the stiffening action of the girth joint is quite an important element in a boiler shell, and its absence was doubtless one of the causes of failure of the single-bottom sheet type.

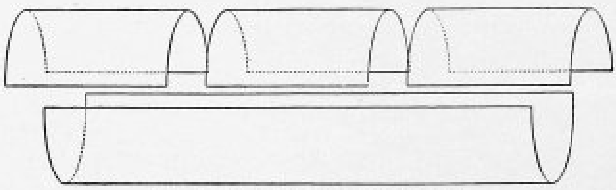


FIG. 5.—SINGLE BOTTOM SHEET SHELL.

In an attempt to take advantage of the good features of the single-bottom sheet design, so far as this can be done without retaining the bad ones, many boiler makers are now favoring the type shown in Fig. 6. This differs from the three-course design, illustrated in Fig. 2, only in the fact that the shell is built in two courses instead of three, the courses in Fig. 6 being, for a given size of boiler and style of setting, half as wide again as those employed in Fig. 2. The idea is that such a construction offers nearly as smooth a surface along the bottom of the shell as the one shown in Fig. 5, while at the same time it has one girth joint in the middle of its length, to provide for the stiffening of the shell. There can be no doubt, we think, but that the preference, among the various designs herein illustrated, lies between the form shown in Fig. 6 and that shown in Fig. 2. It will therefore be of interest to compare these two designs in some degree of detail.

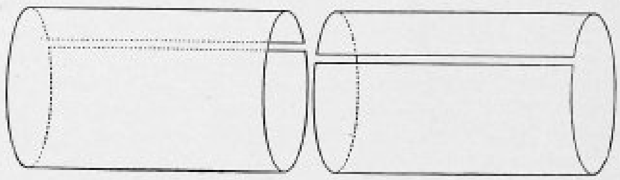


FIG. 6.—TWO-COURSE SHELL.

As we have already said, our own preference is distinctly in favor of the three-course shell. We do not mean by this that we should decline to insure two-course boilers, for we have insured them in the past, are doing so at the present, and shall doubtless continue to do so in the future, so long as we have nothing to criticise but the *type;* that is, so long as our inspectors report that such boilers of this type as are proposed for insurance are made of good material, are well constructed, are under good management, and are in satisfactory condition as respects deterioration and the development of special defects of any kind.

Nevertheless, if the adoption of the single-bottom sheet boiler was a mistake, we fear that we are journeying along the same road, to a certain extent, if we adopt a two-course construction, such as is shown in Fig. 6. We believe that the "breaking" of the longitudinal joint into three parts affords a much better and safer construction than is obtained by breaking it merely into two parts, and we believe, further, that the extra girth joint that is obtained in the three-course construction is of much value in stiffening the shell. So far as this latter consideration is concerned, our friends who advocate the two-course design can say, in reply, that more girth joints would stiffen the shell still further, so that, logically, we ought to advocate the old style of construction, with many courses, if our view of the case is a sound one. This would be mere

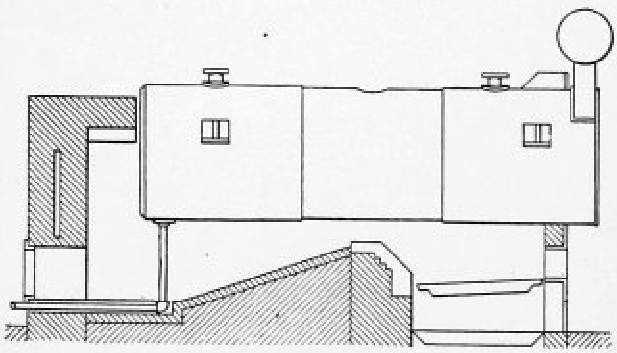


FIG. 7.—THREE-COURSE BOILER IN SETTING.

sophistry, however, for the truth must lie between the extremes, here as elsewhere. There is doubtless a medium type that is best and safest, so far as the number of courses is concerned, and we believe that the three-course boiler *is* that best medium type, since it provides a sufficient amount of stiffness in the shell without making use of an unreasonable number of girth joints.

Builders occasionally advocate the two-course type on the ground that when a boiler is under 18 feet in length, there is very little room left in a three-course shell for riveting on the steam flanges and the supporting lugs, after space has been allotted for the head braces at each end. We incline to the belief that there is little force to this argument, however, because relatively few builders have ever suggested it.

So far as the cost of the boiler is concerned there does not appear to be any reason for preferring either type; for the slightly increased cost of the plates, in a two-course boiler, is offset by the somewhat greater amount of labor involved in the construction of the three-course one.

The real question appears to be, whether it is better to cut the stiffening effect of the girth joints down by one-half, and thereby save exposing one girth joint to the furnace gases, or whether it is better to keep up the stiffness, at the cost of having two girth joints exposed instead of one. Our experience indicates that serious trouble is *far* more likely to come from lack of stiffness than from the exposure of a girth joint to the gases of the furnace. Moreover, it is not altogether the *number* of the girth joints that must be considered, in deciding upon a design, for their *position* with respect to the distribution of the heat in the furnace is also an important factor. At the bridge wall, for example, the highly-heated gases from the furnace are concentrated against the boiler shell, and it is desirable, in our judgment, to keep the girth joints well away from this region of concentration. It is only fair to say that with our plan of setting, and the care that we recommend in the construction of bridge walls, we have had little or no trouble from this source with either two-course or three-course shells. A comparison of Figs. 7 and 8, however, will make it evident that in the case of the designs here shown, at all events, the three-course boiler gives the least exposure to whatever danger there may be in the concentration of heat at the bridge wall. Of course we are well aware that the two-course boiler is often built with the dry-sheet bolted to the front head, so that the girth joint can be thrown further back from the bridge wall; but even in that case we feel that it comes too close to the wall for the best practice. Moreover, the setting has to be of the "flush-front" form, in order to take advantage of this element in design, and we prefer the "overhanging front" in any event, although we specify either of these fronts, in designing new boilers, as our patrons may desire. We have not selected the design shown in Fig. 8 for the purpose of being unfair to the two-course construction, but because, when the design is *alike* in the two types save for the single difference of using two courses in one case and three in the other, the danger of which we speak is brought to the attention more directly and forcibly.

Another element to be considered, and by no means a mean one, is the probable expense of repairs in the event of the boiler becoming over-heated from low water, or from the accumulation upon the fire sheets of scale, mud or grease. Our records show that when extreme over-heating occurs in a horizontal tubular boiler, the whole bottom is likely to bag in a boiler having less than three courses, while in a three-course or four-course boiler the resistance due to the stiffening effect of the girth seams materially lessens the extent of the injury; and this means that in the event of an accident from over-heating, the cost of repairs is likely to be considerably greater with the wider courses than it is with the narrower ones. Of course, this consideration has the greatest weight in the case of the single-bottom sheet type, but it is also worthy of attention in the two-course type.

To sum up our views on this question in a general way, we may say that while the two-course boiler is without doubt a

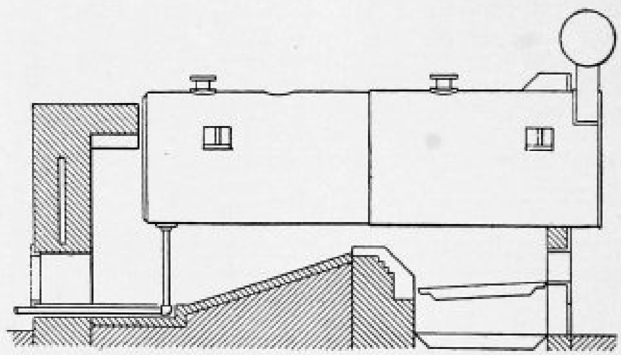


FIG. 8.—TWO-COURSE BOILER IN SETTING.

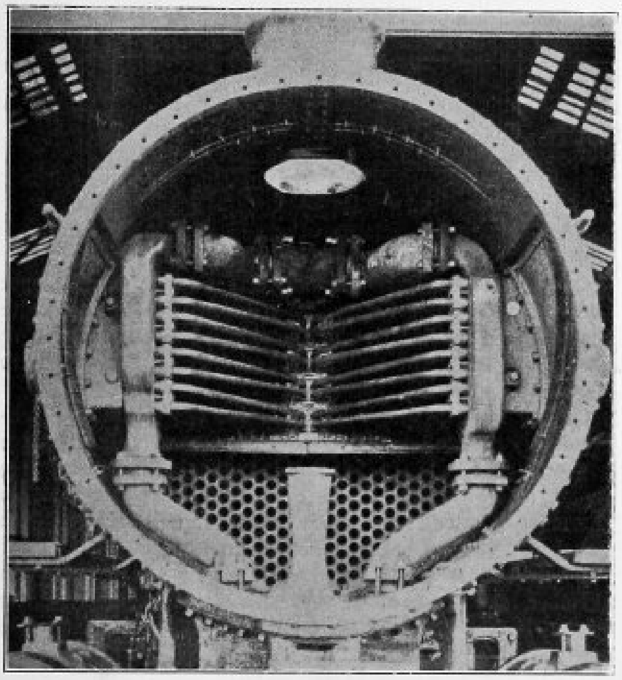
great improvement over the single-bottom sheet type, we believe that it is nevertheless somewhat inferior to the three-course type; and the superiority of the three-course type consists (1) in the greater degree of stiffness afforded by the extra girth joint; (2) in the fact that the longitudinal joints are better "broken"; (3) in the smaller probable cost of repairs in the event of severe over-heating, and (4) in the greater distance of the girth joints from the bridge wall, as the boilers are ordinarily set.

It must not be assumed that because a boiler sustains a hydrostatic pressure successfully, conclusive evidence has thereby been adduced that it is safe. In any case, the hydrostatic test should be supplemented by the hammer test. Local thin spots, a mass of scale covering up a local weakness, or other conditions may exist which are not brought out by the hydrostatic test.

LATTER-DAY DEVELOPMENTS OF THE AMERICAN LOCOMOTIVE.*

BY H. KEITH TRASK.

It is a fact to be deplored, but one that cannot be gainsaid, that American locomotive practice has followed rather than led European practice in matters of design relating purely to increased efficiency from the standpoint of economy. This condition has been brought about chiefly because in Europe fuel is so much more expensive than it is in the United States, that it has always been imperatively necessary to get the utmost possible benefit from every pound of coal burned in the locomotive fire-box. This condition led European designers to consider the advantages offered by superheated steam long before the question was seriously taken up in America. How-



FIRE-TUBE SUPERHEATER. (AMERICAN LOCOMOTIVE COMPANY.)

ever, as the disadvantages attending the use of the compound locomotive were realized the advantages offered by superheating were more thoroughly canvassed. Briefly summed up, the advantages of superheated steam over saturated steam are as follows:

I. Increased volume. The volume of superheated steam has a rate of increase directly proportional to the rise of temperature.

II. A reduction of condensation in the cylinders and steam passages. With saturated steam a large percentage of the total quantity precipitates and passes through the cylinders without doing any work.

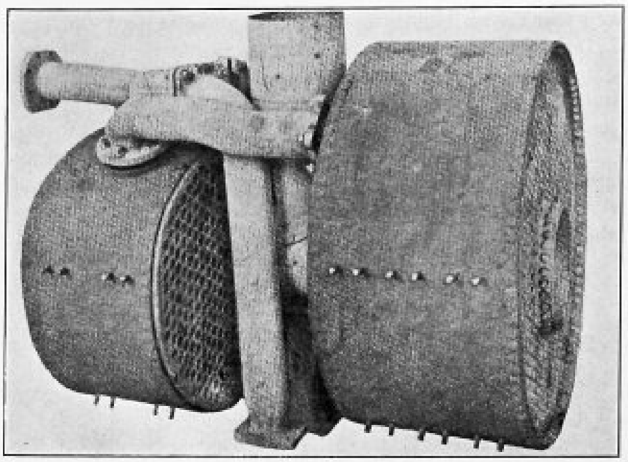
III. Low thermal conductivity. Saturated steam is a good conductor of heat, while superheated steam is not.

IV. Reduction of back pressure, since a smaller volume and weight is required than with saturated steam to do a given amount of work.

V. Increased hauling capacity, since the mean effective pressure is higher, on account of the increased fluidity, due to the tendency to complete gasification.

VI. Lower maintenance costs for the boiler, since for a given power a lower working pressure may be effectively employed.

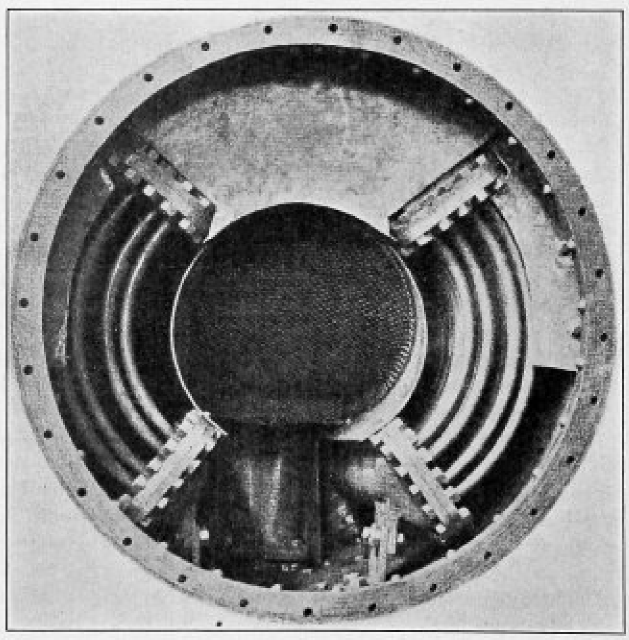
* From *The Engineering Magazine*.



JACOBS SMOKE-BOX SUPERHEATER.

As developed for use on American railroads the superheater is of two types—the smoke-box—chiefly advocated by the Baldwin Locomotive Works, and the fire-tube, a modification of the design of Wilhelm Schmidt, a German engineer, by H. H. Vaughan, of the Canadian Pacific Railway. While both types were originally introduced several years ago, it is only within the past twelve or eighteen months that the American railroad world in general has awakened to their possibilities, and they are being applied to many new engines now building for various roads. The Canadian Pacific was the first road to adopt the fire-tube superheater exclusively, while the Santa Fe, although not the first road to test the smoke-box design, was the pioneer in adopting the device as a standard.

The fire-tube superheater, as its name implies, is a design wherein the superheater tubes are inserted in large fire-tubes that take the places of a certain number of the ordinary boiler flues. The superheater tubes run to the rear of these fire-



SMOKE-BOX SUPERHEATER. (BALDWIN LOCOMOTIVE WORKS.)

tubes, where they meet a return bend just ahead of the back flue sheet, and return to the header at the front flue sheet. They are so arranged that the four superheater tubes in each fire-tube form a unit that may be disconnected, in the event of any trouble arising, without disabling the rest of the superheater. The steam from the throttle must traverse a distance equal to twice the length of the boiler tubes exposed to the hot flue gases, and in so doing attains a high degree of superheat.

In the smoke-box superheater the steam from the throttle arrives at the front flue sheet in the ordinary manner, but thence, instead of being conducted directly to the cylinders by the ordinary smoke-box steam pipes, it enters two long cast steel drums, one on each side, of the upper part of the smoke-box, their axes parallel to the axis of the boiler and to each other. These drums are connected directly to the tee-head of the dry pipe. On the bottom of the smoke-box a similar pair of drums is connected to the live-steam passages in the cylinder saddle. The two right-hand and two left-hand drums are connected by rows of tubes bent to the radius of the smoke-box and divided into sections, each section having about the same cross-sectional area as would the ordinary steam pipe, in such a manner that the steam must pass up and down through the tubes several times before entering the cylinders. Baffle plates are provided whereby the gases and products of combustion are made to circulate between all the superheater tubes before finally passing out of the stack.

The chief advantage claimed for the fire-tube superheater is economy of operation, due to the high degree of superheat attained.

Its chief disadvantage is that on account of the large fire-tubes the boiler is robbed of a certain amount of heating surface, and that in their swift passage through the flues the gases do not give up all the heat they should, and, consequently, they pass out of the stack at a wastefully high temperature. Minor objections are the difficulty of maintaining packing, and the necessity for the special preparation of the locomotive boiler to apply this type of superheater.

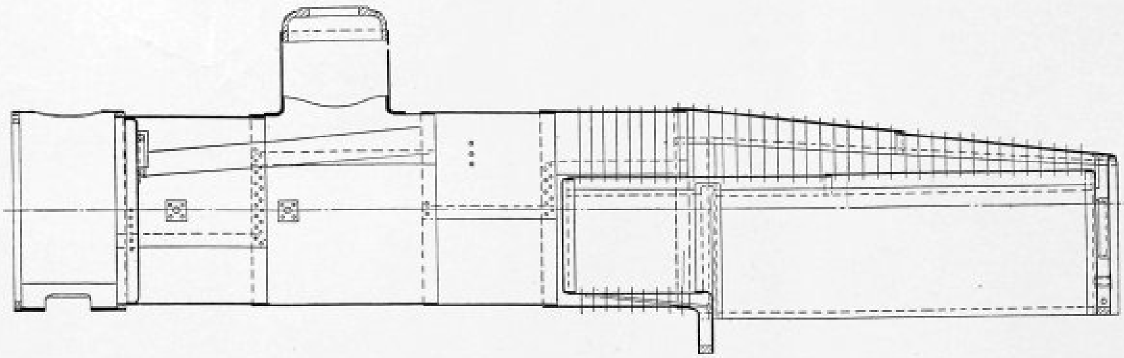
The smoke-box superheater does not attain so high a degree of superheat, but its advocates claim that what it loses in theoretical efficiency thereby, it more than regains from a practical standpoint, in its simplicity and ease of application and operation. Being placed altogether in the smoke-box it does not rob the boiler of any of its heating surface, nor does it require any special arrangements for its installation. All the gases which are circulated through it have already done their work in the boiler flues, and, consequently, pass out of the stack at a materially lower temperature than in the case of the fire-tube type.

One advantage, and an advantage that would outweigh many drawbacks in a part of the country where bad water prevails, both types of superheaters possess in common; they obviate all the trouble and annoyance of priming in the boiler. No matter how much entrained water enters the dry pipe with the steam, the steam that reaches the cylinders is an absolutely dry and fluid gas.

The slightly increased difficulties of lubrication with superheated steam are as nothing compared with the trouble and annoyance experienced in attempting efficient cylinder lubrication in bad-water districts where saturated steam is used.

FEED-WATER HEATING.

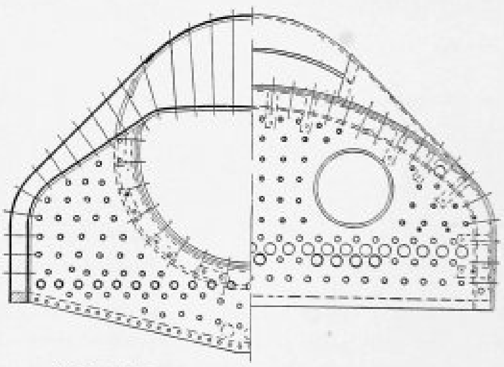
The logical complement of the superheater is the feed-water heater. This device is, as yet, in the experimental stage for the locomotive, but there appears no good reason why on very large locomotives it should not have a place. The pioneer form of feed-water heater for a locomotive in the United States was a modification of the smoke-box superheater, applied to an engine of the Central of Georgia Railway by the Baldwin Locomotive Works.



OLD-STYLE WOOTTEN BOILER WITH COMBUSTION CHAMBER. (BALDWIN LOCOMOTIVE WORKS.)

On the large Mallet compounds for the Southern Pacific, previously referred to, a feed-water heater of a different type has been installed. In this instance the boiler is very long, some 51 feet, but the distance between front and back flue sheets of the boiler proper is but 21 feet, thus keeping the length of the flues within practical limits.

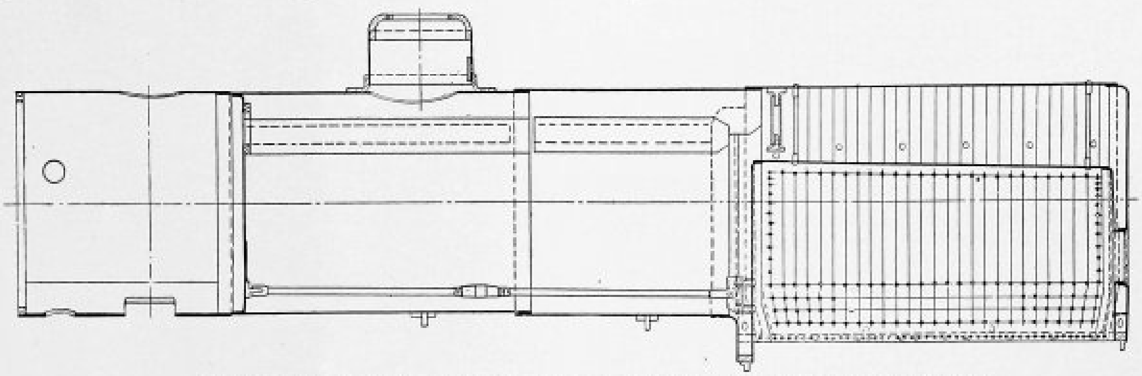
Directly in front of the flue sheet is a short combustion chamber, and forward of this combustion chamber another section of the boiler shell, containing the same number of flues as the barrel of the boiler proper. This section is short, the flues being but 5 feet 6 inches in length. The feed water is pumped first into this section of the boiler through a check placed at the center line in the usual manner. No steam is generated herein, but the temperature of the water is materially raised. As this chamber fills up the incoming feed raises the pressure of the water until it is sufficiently high to lift the check between the feed-water heater and the boiler proper, when the heated water passes into the boiler to be converted into steam. A superheater, or more properly a reheater, is placed in the smoke-box of these locomotives to reheat the exhaust steam from the high-pressure cylinders before it passes into the low-pressure cylinders.



CROSS SECTION OF OLD-STYLE WOOTTEN BOILER.

LOCOMOTIVE BOILERS.

The development of the locomotive boiler has not, in a measure, kept pace with the strides made in other important details of the machine. Very early in the history of the American railroads the various experimental types crystalized into a type of boiler of which the general characteristics remained the same for many years. This was the cylindrical barrel fire-tube boiler with a rectangular fire-box. The cylindrical portion of the shell immediately in front of the fire-box was usually increased in diameter in order to give more space for steam over the fire-box crown sheet. This enlargement caused this style of boiler to be called wagon-top, and the wagon-top boiler, or the straight-top boiler of generally similar form, was the only type used in Americ to any extent up to 1877. The grate area of this boiler was restricted, inasmuch as the width was confined to that which could be obtained when the boiler was set between the frames, or, at most, on top of the frames between the wheels, and the length was limited to the distance to which the fuel could be effectively fired.

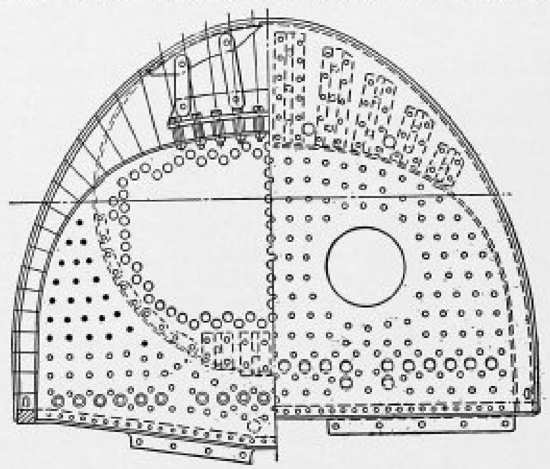


MODIFIED WOOTTEN BOILER WITHOUT COMBUSTION CHAMBER. (BALDWIN LOCOMOTIVE WORKS.)

In the mining of anthracite coal large banks of very fine dust, which is screened out of the coal in passing through the breaker, rapidly accumulate. It was impossible to burn this fine coal, or culm, in any ordinary fire-box or domestic stove, and the material was consequently a dead loss to the coal companies. In 1877, John E. Wootten, superintendent of motive power of the Philadelphia & Reading Railroad, designed a fire-box to burn this culm, which was very successful, and, in a modified form, is widely used to-day by a number of the Eastern coal roads. In his fire-box design Mr. Wootten raised the center of the boiler sufficiently to permit spreading the fire-box over the top of the wheels, and making its total width practically that of the limit of width of the locomotive. The strength was made as great as was possible for effective firing. A short combustion chamber was applied, and a very fine grate used. In later designs the combustion chamber has been omitted, and the fire-box altered in minor details. It is now sometimes used for bituminous or semi-bituminous coal, owing to the low rate of combustion which the large grate area renders possible.

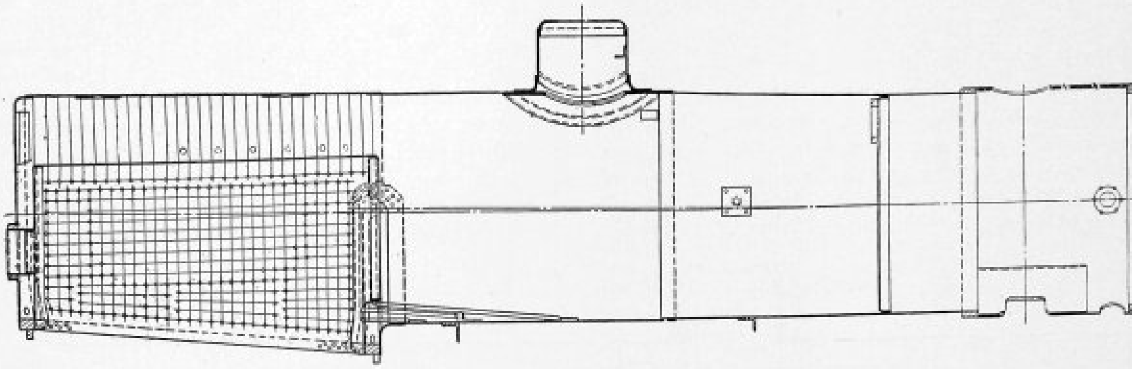
From the time of Wootten until the latter eighties no attempt was made to introduce any radical innovations in the locomotive boiler. About 1887 or 1888, George S. Strong evolved a design which had no real influence in American practice, but is interesting in view of a later development along somewhat similar lines. The Strong boiler consisted of a cylindrical shell, constructed in the ordinary manner, with a combustion chamber at the rear end. Connected to this combustion chamber were two cylindrical fire-boxes, whose axes lay parallel in the same horizontal plane. This boiler did not meet with much favor and soon disappeared from view.

In 1901 Cornelius Vanderbilt designed a fire-box with the object of dispensing with stay-bolts, a most annoying item of boiler mantenance. The Vanderbilt boiler consisted of an ordinary cylindrical barrel with an extended wagon top. Instead of the usual rectangular fire-box, a cylindrical corrugated furnace of the Morison type was employed. This furnace tube, which was of large diameter, was suspended eccentrically in the rear end of the boiler, with its axis inclined rearwardly and below the axis of the boiler. It was supported at the rear end by being flanged and riveted to the back boiler head, and at the forward end the weight was carried partially by several rows of sling stays, and partially by a circular steel casting, which formed a manhole between the fire-tube shell and the boiler shell at the bottom. A similar manhole casting was provided about half-way to the rear of the fire-box. These two manhole orifices served for the removal of the ashes. No stay-bolts whatever were used, the corrugations of the fire-tube rendering it amply strong to resist any tendency toward collapse. The grates were set inside of the tube upon suitable frames at a distance of about one-third of the diameter from the bottom. A sheet iron liner was provided under the grates to protect the corrugated tube from injury by the hot ashes. About two-thirds of the distance forward was utilized for grate area, the remaining one-third forming a combustion chamber, separated from the grates by a firebrick wall. The orifice at the rear end of the tube was closed by a casting lined with firebrick and provided with a suitable fire-door.



CROSS SECTION OF MODIFIED WOOTTEN BOILER WITHOUT COMBUSTION CHAMBER. (BALDWIN LOCOMOTIVE WORKS.)

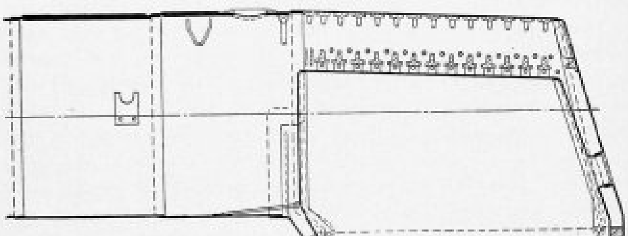
This boiler did not prove as successful as its inventor had hoped. While the absence of stay-bolts was a considerable advantage, this advantage was more than offset by the drawbacks presented by the necessarily restricted grate area. One of the claims put forth by the advocates of the Vanderbilt boiler was that the corrugations of the Morison tube would



LONGITUDINAL SECTION OF SEMI-WIDE FIRE-BOX, RADIAL-STAYED BOILER. (AMERICAN LOCOMOTIVE COMPANY.)

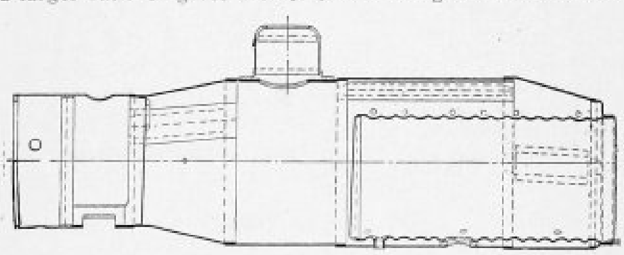
present sufficient additional heating surface to compensate for the restriction of grate area. This did not prove to be the case in practice. Moreover, the large radiating surface of the back-head casting, protected from the fire only by a single layer of firebrick, and lagged on the outside with asbestos, made the cabs of the locomotive extremely hot, and imposed a genuine hardship on the engine crew.

In an endeavor to remedy some of the unsuccessful features of the Vanderbilt design the Baldwin Locomotive Works produced a boiler with three Morison tubes suspended in the boiler shell with parallel axes, and arranged in section as an inverted cone. The three fire-tubes were connected to a common combustion chamber, and were arranged for burning oil as fuel. This arrangement did not meet the expectations of its designers.



FIRE-BOX OF SOUTHERN PACIFIC MALLET LOCOMOTIVE. (BALDWIN LOCOMOTIVE WORKS.)

While these various unsuccessful attempts to improve the locomotive boiler were being made the need of a fire-box with a larger ratio of grate area to total heating surface than was offered by the old-style narrow fire-box was daily being more keenly felt. The Wootten fire-box made it necessary to place the cab on the center of the boiler ahead of the fire-box, thus separating engineman and fireman. In some States this was considered so grave a menace to safety that legislation was attempted to compel the carrying of a third man upon the engine as a precautionary measure against the sudden disability of the engineman, which might pass unnoticed by the fireman until disaster was unavoidable. The great width of the fire-box also precludes the use of a wheel sufficiently large for high speed in some types of locomotive, owing to the necessity for keeping the center of gravity within reasonable limits. These considerations led to the gradual evolution of a fire-box much wider than the older types, but not so wide as to preclude placing the cab at the rear end of the boiler. This type of fire-box is now employed almost exclusively for locomotives of large dimensions. It is usually of the crown-bar or radial-stayed type, with the back head sloped forward from the bottom to the top to give more room in the cab. In some instances the flat-topped Belpaire type of fire-box has been used, although this style of box is usually considered more difficult to maintain than the radial stayed. A fire-box of this character for a typical consolidation locomotive with a 22-inch cylinder would have a grate area approximating 50 square feet, as against about 30 square feet for the old narrow type, and from 80 to 100 square feet for the Wootten type of fire-box.



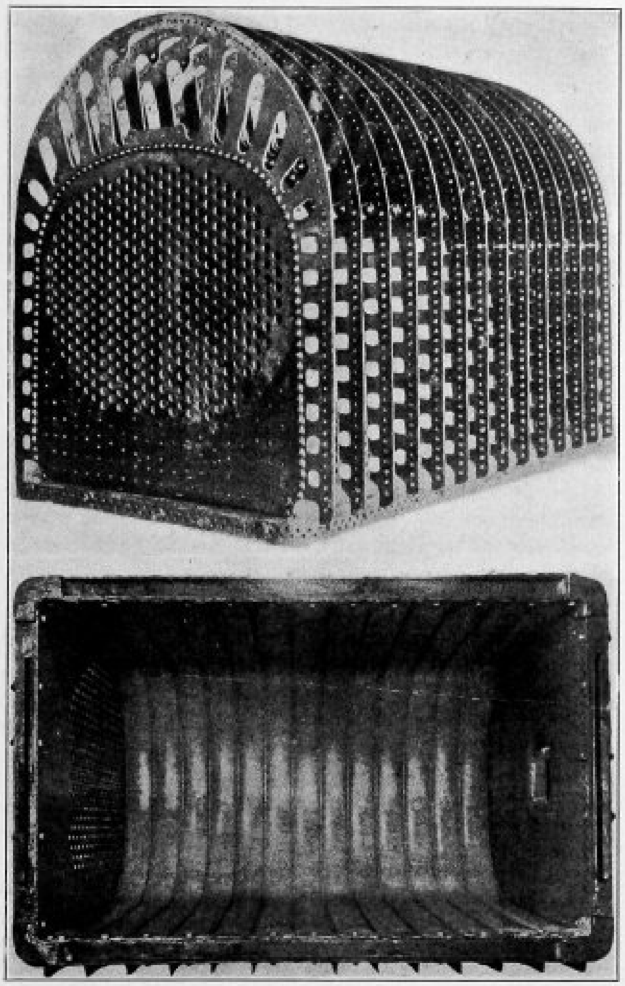
VANDERBILT FIRE-BOX. (AMERICAN LOCOMOTIVE COMPANY.)

It is clearly recognized that a locomotive boiler in which the use of stay-bolts can be avoided, and in which the attainment of this end will not entail complications sufficient to neutralize the advantages gained, is a very desirable thing. The most recent effort in this line is that of Messrs. Jacobs and Shupert, of the Santa Fe. This fire-box is built up in sections integral with the shell of the boiler, formed of plates flanged into a U or shallow trough section and bent around to the radii of the boiler shell and the fire-box. The convex side of the fire-box plates is presented to the fire, and the plates of the outside shell occupy the same relative position; that is, with the convex side turned inward toward the water space. The various sections are connected to each other, and, as a whole, by transverse bulkhead plates, whose outline is that of the space between the outside shell of the boiler and the fire-box shell. Through rivets connect these bulkheads with the flanges of each adjoining set of outside and fire-box plates. The bulkhead plates are spaced about 8 inches from center to center, and, as will be seen, are designed to act as stays to the shell and fire-box. In addition to the stay-boltless feature, the inventors claim for this boiler, that, owing to the slight corrugations in the fire-box sheets, where they are joined by means of the bulkhead plates, the effective fire-box heating surface is somewhat increased.

It would be obviously unfair to criticise a design that is, as yet, untried.* The weak feature of this fire-box would seem to be the number of seams to calk that are directly exposed to the fire. At the point of junction of each section with the next there are two seams that run transversely entirely around the fire-box from the mud-ring on one side to the mud-ring on the other. It would also appear that it may be difficult to form a satisfactory connection between the sectional sheets of the fire-box and the mud-ring.

* Since this was written extended trials of the Jacobs-Shupert fire-box have been made on the Santa Fe, with results that are reported to be very satisfactory. The fire-box has been adopted on the four huge Mallets just completed for the Santa Fe by the Baldwin Locomotive Works, and on locomotives built in the Santa Fe shops.

From the foregoing review it may be seen that the past decade has indeed witnessed a radical development in the American locomotive. Some of the most far-reaching improvements in design have occurred during the past five years. Had any man seriously prophesied five years ago that we should have locomotives running on our roads with sixteen wheels connected he would have been a target for ridicule



DETAILS OF THE JACOBS-SHUPERT STAYLESS FIRE-BOX.

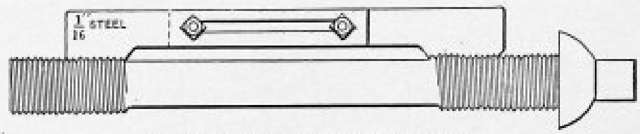
and, probably, his sanity would have been a matter of investigation. To-day it would be a bold man who would venture a conjecture as to where the increase is to stop.

That the Mallet type of engine is to be the freight locomotive of the future seems reasonably certain. In passenger service there are several lines of development possible. That some form of balanced engine will be required for high speed seems probable. Whether this balanced engine shall be a four-cylinder compound or a three- or four-cylinder simple engine using superheated steam, time alone can show. One thing is certain, in spite of the predictions of those who would have us believe electricity to be the power of the future, the steam locomotive must remain the principal factor in long-distance land transportation for many years to come. The introduction of the large Mallet engine has robbed the electrical advocates of one of their stock arguments, that we have arrived at the limit of size and capacity in the steam locomotive.

If for any reason it becomes necessary to put a patch on a boiler the patch should be put on the inside, not on the outside.

Thread Gage for Stay-Bolts.

Radial stays are a hard thing to fit into place, according to some boiler makers, because the threads in the boiler plates and the threads on the stay-bolt will not mesh in both sheets at the same time. I knew of one case where a boiler maker spent two days putting in five stays, and these were obtained by sorting over about 100 stay-bolts. Schemes are tried of having the tap so made that the threads in both plates will be as on a continuous rod, and this helps a lot; in fact, it is necessary to have the holes exactly in line. But another trouble often comes from the fact that the stay-bolts are turned up in a lathe which is so worn that in a foot or two of length the



THREAD GAGE APPLIED TO A STAY-BOLT.

pitch is a little off, which changes the position of the threads so that they cross when the bolt is screwed into place in the boiler plates. It will pass through the outside sheet all right, but will not fit into the inner sheet. Now, if this stay-bolt is lengthened a little, by hammering, so that the threads are moved a little ahead until they will exactly fit into the threads of both sheets, everything works smoothly.

The illustration shows an adjustable gage that can be used in spacing these threads. This gage can be set by the tap that was used in making the threads in the plates, or it can even be placed in the holes and set to the actual threads in the sheets. Then the bolts can be drawn out with a hammer to fit the gage, and a lot of hard work will be eliminated.—A. G. Johnson in *Machinery*.

A Steam Boiler Incident.

Seventeen years ago an enterprising farmer living near Boston purchased a portable steam pump to water his farm. Every summer he has had one of the young men in the neighborhood run it, under the supervision of Mike, the foreman, whose word was law. This summer the boiler leaked so badly that the facts came to my attention. The boiler tubes became so overheated and loosened that there was not a single one which was tight. In former years when they leaked badly, Mike, with a hammer and chisel, would calk them until they were fairly tight. Several years ago the steam gage was stolen, and since that time the "engineer" estimated the pressure by the rate the pump worked with the throttle wide open. How he estimated it when the pump was not working was not made clear to me. The water used in the boiler was the same as that used in the pump, and it came from a dirty frog pond. Small fish and eel grass were continually thrown out of the discharge nozzle of the pump, and the natural inference was that they were just as frequently thrown into the boiler. The water glass was so dirty that even if there had been any water in it it could not have been seen; as Mike explained, "It was so stuck up with mud that you couldn't ever depend on it."

Once (long ago) Mike opened a hand-hole to clean out the boiler; but, as he said, "There was such a mess in there that it would have taken a whole day to clean it out, and what was the use, since it was running all right as it was." And the mud stayed in there. In all these seventeen years no repairs have been made to the boiler, it has never been inspected, the inside has never been cleaned, its safety valve and steam gage (when it had one) have never been tested, and it has never had anyone with a license to run it. In spite of all this, the owner refuses to have any repairs made, saying that "It isn't worth it, and as long as it will pump water let it alone and don't fool with it."—E. M. S. in *Machinery*.

LOCOMOTIVE WORKS AT WIENER-NEUSTADT.

Special Agent Capt. Godfrey L. Carden, writing for the *Daily Consular and Trade Reports* from Wiener-Neustadt, Austria, describes his recent inspection of the locomotive works at that place as follows:

The Wiener-Neustadt Locomotive Works are one of the important private locomotive plants in Austria. The shops are located in Wiener-Neustadt, a city of some 28,000 inhabitants, and distant about one hour's time by fast train service from Vienna. At the time of my visit 2,200 men were employed. General Director Richard Heindel afforded every facility to inspect the shops. The full name of this establishment is Actien-Gesellschaft der Locomotivfabrik vormals G. Sigl in Wiener-Neustadt. During the summer months business was so good that foreign orders could not be accepted because of the heavy demands of the Austrian State Railways. Ordinarily, the Wiener-Neustadt shops are active bidders for locomotive work for the Roumanian, Servian and Italian railways.

CAPACITY AND OUTPUT.

The total output capacity of the Neustadt plant is about 120 locomotives of all sizes per year. This is not a very heavy output when one considers the five locomotives per day capacity of one of our American works, but in making comparison of this sort it is necessary to reckon on the types of locomotives built. Wiener-Neustadt, in common with other European shops, constructs copper fire-boxes and uses copper stays and bolts. Great care and attention are given to finish and appearance, and the idea prevails that a machine must operate for twenty years or more. These views are opposed to American practice, in so far as they subordinate immediate work capacity to longevity, and by work capacity I mean bar-pull. Naturally, in a shop where care and attention to detail are of paramount consideration one expects to find good workmanship, and it may be stated that the work which came under my observation is of as high a standard as I have seen on the Continent of Europe. Observations of this sort are, of course, relative, and are based on comparisons. In visiting different shops one finds, perhaps, special aptitude in some particular detail more highly evinced at one rather than at several works. At Wiener-Neustadt the boiler work was especially noticeable, and aside from the good workmanship there this part of the establishment is the most modern and interesting. Locomotives of all sizes up to 1,200 horsepower are built. This latter figure may not sound large compared with the 2,000-horsepower engines used on several leading railways in the United States, but for Continental work 1,200-horsepower engines are very large engines. In the building of locomotives, when called upon to supply superheaters for the Austrian State Railways, recourse is had to the Golsdorf type.

The Wiener-Neustadt works have been in existence for about fifty years. Tools are in use to-day in the shops which have been availed of upward of forty years. One man stated in my presence that he had been working steadily at the same machine for twenty-eight years. The tool was a Sigl lathe for turning down crankshafts. This man receives between 8 and 9 kronen per day (1 krone = 20.3 cents).

EXTENSION OF WORKS.

At the outset the efforts of the plant must have been devoted in part to machine-tool construction, for many tools were observed bearing the name of Sigl, the originator of the works. The history of the establishment was not without vicissitudes, and in recent years several changes have been made in the management. General Director Heindel has been in control during the past two years, and the busy appearance of the shops gives every indication of prosperous conditions. New additions are constantly being made, and during the past year a sum approximating 2,000,000 kronen ($406,000) was expended on new boiler and machine shops. The new machine shops are quite apart from the old works, and while the buildings are completed and machine tools are being installed, the equipment is not complete. It is very apparent the management contemplates many important additions to the machine-tool equipment, both to meet the demands of the new shops and to modernize the older portions of the works. This is seemingly the policy that is planned, and one which should be borne in mind by manufacturers possessing high-grade machine tools especially adapted to locomotive work. The entire spirit of the Wiener-Neustadt administration is eminently progressive, and it is my opinion that manufacturers producing machine tools of more than ordinary merit will find that any representations they make on the subject will be welcomed at this establishment.

MACHINES EMPLOYED.

The Wiener-Neustadt works are building all locomotives on the plate-frame form. These plate frames are cut out with oxygen gas. In this respect the Wiener-Neustadt shops follow the Borsig practice. Practically all material entering into the locomotive construction comes from Austrian territory. In all, there are about 1,300 machine tools in service in the works. In the original shops, in fact in all the buildings except those erected during the past two years, one finds many old tools. The name "Sigl" is on many of these tools, yet Sigl, as a machine-tool maker, no longer exists. In the new shops there are many German tools, although a Bullard boring mill was noticed in one of the latest installed sections. Vulkan, the Vienna machine-tool works, has supplied a number of machines of a varied sort. The lathes used in general are very old, but it was gratifying to observe that in recent additions an American tool was on the ground in the shape of a heavy 20-inch Lodge & Shipley engine lathe. There were quite a number of unmistakable American-made tools on the floors, but with the names of the makers missing.

The planers used are, for the most part, as old as the general run of the lathes. There are only two modern planers, so far as could be observed, in the entire plant. These two were from the G. A. Gray Company, Cincinnati, Ohio.

AMERICAN AND OTHER FOREIGN TOOLS.

Four slotters from the Bement-Niles Company, Philadelphia, were seen. The name and numbers of the machines were cast in the framing and had not been effaced. The numbers were 680, 712, 713 and 715. Prentice Bros. Company, of Worcester, Mass., are represented by a greater number of tools than any other American firm. The Prentice machines are for the most part upright drills. There was one unmistakable Gisholt turret lathe, but with the name missing.

The shaper line at this works is also old. There is one line of crank shapers in service, as made by Vulkan, which was installed fully thirty years ago.

Some of the more recent German-made tools in use are heavy machines, and nearly all, or the more conspicuous, are to be found in the new shops. Grafenstaden has supplied several tools for cylinder boring. Sondermann & Steirr, of Chemnitz, have supplied several heavy vertical drills, and D. G. Diehl, of the same place, has also been drawn on extensively.

There are very few English tools in service. I saw only Kendall & Gent radial drills and some slotters from Maclea & March.

A Mayer & Schmidt vertical grinding machine was present, but was criticised. In previous reports it has been mentioned that the opinion prevails that American grinding machines are not equaled by the best grinding machines of European make.

All tools in the Wiener-Neustadt works are to be operated by electric power, either from motor attached or by overhead shafts driven by electric motors placed at various points throughout the shops. Two Parsons turbine engines have been installed, and furnish collectively about 1,600 horsepower.

The Saechs Maschinenfabrik vorm. Rich. Harmann, of Chemnitz, and Ernst Schiess, of Düsseldorf, have supplied some heavy tools for Wiener-Neustadt. Schiess is present with a heavy tool for turning off locomotive wheel tires, and Hartmann has supplied a heavy turning and boring machine.

In the boiler shops there is a 15-meter long machine from the Vulkan Works, of Vienna, designed for drilling plates. Sondermann & Stierr have furnished a four-spindle machine for drilling boiler heads, a tool not unlike that made by the Foote-Burt Company, Cleveland, Ohio. There is also a fine spindle machine in service for the same character of work from the German firm of J. A. Maffei, Munich. Practically all the heavy tool orders seem to have been taken by the Germans.

The pneumatic tools in use in the boiler shops are of German make. There are in use also tools made in England, Austria-Hungary and Switzerland.

A day's work at Wiener-Neustadt embraces 9½ hours. Work commences at 7 A. M. and stops at 6 P. M., with an interval of 1½ hours at midday. On Saturdays the shops close at 5 P. M. The men are paid on the basis of a fixed valuation for work performed. If the work is not completed by the week end, the workmen are given advances on the final price for the work. Good workmen at Wiener-Neustadt receive wages varying from 8 to 9 kronen ($1.62 to $1.83) per day. In exceptional cases sums as high as 12 kronen ($2.44) per day are earned.

CORROSION AND PITTING OF BOILERS.

In observing the overhauling of some boilers recently, I saw that the interior enemy—corrosion—had gotten in its work. The boilers were unsafe for continued use and had been condemned. There were plates in the boilers so badly pitted by corrosion that the thickness had been reduced to dangerous thinness in many places. And anyone who goes about very much among the steam power plants will meet with similar cases. There are varying conditions of water, condition of the boilers, application of the steam and general employment of the boiler that tend to change the average order of things. Generally the important kinds of corrosion may be classed under the headings of honeycombing, wasting and grooving. Honeycombing and pitting are practically alike in characteristics. Plates thus affected are dangerously near the rupture mark, and the knowing men will always remove such plates by substituting new plates, providing that it will pay to do so. Often a boiler gets so badly pitted that you have to abandon it. Second-hand boilers are often pitted internally.

The other day I witnessed the results of a blow-out of a plate in a sawmill, where an antique boiler had been put in for economy reasons. The boiler looked good enough on the outside, but the steady pitting inside had been in progress for some years, and so weakened the plate that the metal gave way.

A man who had charge of the boilers in a flour mill showed me how he had been deceived as to some pitted plates. The pitting had been going on in the boilers for some time. But an incrustation had set up, and this material so formed over the pitted portions that the latter were invisible. Time passed and the pitting continued. Some scale collected, and in removing the scale with chipping chisels the workmen broke through to the thinned and weakened parts of the pitted plates.

By following up the operation of pitting, you will find that at first there are but light evidences of the trouble. But if you have reason to examine the plate sometime later, and if the pitting has been allowed to go on, you will find that the indentures have developed in number and size. These recesses tend to weaken the plates to a danger point. Still later the

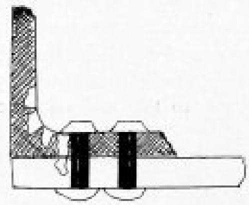


FIG. 1.

pitting will have assumed a form with the impregnations almost passed through the plate. Sometimes you will find that the pitting consists of numerous little holes. Then, again, the pitting takes on the honeycomb order and spreads out more or less. In either case it is bad enough. You will find that pitting, when pitting occurs, is on any plate of the boiler below the waterline.

You will also find the pitting above the waterline in places, particularly where water can collect in spaces about the domes or pipes. Pitting, of course, is due to chemical action.

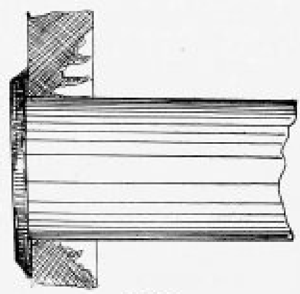


FIG. 2.

Concentrated acids of the water you use are sure to attack the susceptible places of the plates, regardless of patented compounds and any processes you introduce. If the acids are volatile the plates in the steam space will suffer with the plates in other portions of the boiler.

Sometimes the pitting is about the boiler stays, and a wary eye must be kept to avert disaster. In a coal yard where they ran a hoisting engine I saw the workmen engaged in the boiler

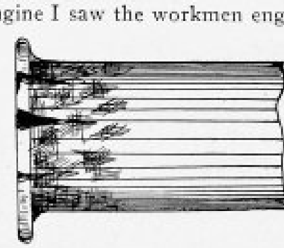


FIG. 3.

fixing the stays. It seems that the pitting and grooving had gotten into the stays at their base, as in Fig. 1, making it necessary to renew these parts. The boiler had to be idle a week for this work.

The following views relate to uniform corrosion in connection with the wasting away of tubes and parts of metal adjacent to the tubes. The water corrodes the parts in an even or uneven manner, often in the form of patches of scale. The conditions are very like common rusting of parts of anything. Cracked scale can be located to expose these conditions. But you cannot determine the depth to which the action had gone unless you drill or cut through the plates. One party thought that he had detected an indication of local grooving and wasting of the plates, and worked on that assumption. He simply did a little cleaning and chipping. He figured that he had fixed the part. Weeks after the boiler head blew out, due to a section of the head having been weakened by the wasting and grooving of the metal in places not readily determined.

One boiler maker showed me a case like that in Fig. 2, in which the plate was scored all about the tube. Yet on the outside the tube appeared to be in first-class order. This party had an electric lamp fitted to the end of a cable, and with this

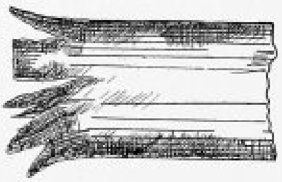


FIG. 4.

flexible cable he was able to carry the 32-candlepower light with him to the spot for examination. I went with him, and was surprised to see the condition of the tube at that point. This man had with him a common reading magnifying lens, which seemed to me to be a very useful instrument for examining the condition of the plates and tubes.

The tube ends are almost always a source of trouble in boilers where it is necessary to use water not suitable for the purpose. Or perhaps the ends get exposed, due to there being no water at all. I have met with such instances. Firemen will get careless in spite of teachings of the engineer. One fireman was in the habit of letting the water get low. The first thing that developed as evidence of low water was loosened and leaky tubes on top. The lack of water permitted heated gases to get to work on the tube ends.

The corroded ends of the tubes looked like Fig. 3 when removed. I once saw a heap of tubes scored to the condition shown in Fig. 4. The engineer told me that he was saving them to be cut down and new ends put on. This is economy and, of course, often done.

But in these modern days the best engineers do not bother with using old truck. New parts are demanded every time. Often it is a paying investment to discard the old stuff to make room for the new, even though there seems to be some life left in the second-hand material.—George Rice in *The National Engineer*.

Introduction of Steel Fire-Boxes.

One of the first problems taken up by the Master Mechanics' Convention, when first formed, was investigating the reliability of steel as material for the construction of locomotive fire-boxes. Up to that time (1869) nearly all fire-boxes used in locomotives in America were made of copper or iron, and much trouble was experienced in keeping the fire-boxes in condition to hold water. The iron sheets laminated and cracked, while the copper thinned out so rapidly that fracture often happened. Among the first master mechanics to try steel was Mr. H. Anderson, of the Chicago & Northwestern, who introduced fire-boxes of "Cyclops" steel, while the Pennsylvania Railroad introduced fire-boxes of steel made by Hussy, Wells & Company, Pittsburg. These experiments proved so successful that steel came gradually into favor, but great opposition was manifested against it for many years.—*Railway and Locomotive Engineering.*

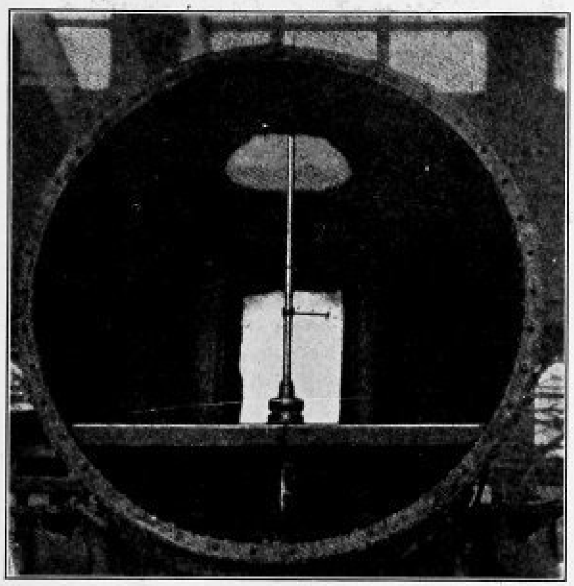
THE NEW GERMAN STEAM BOILER LAW.

On January 14 a new law, regulating the installation of steam boilers, comes into force in Germany. This law, in comparison with the old regulations in force since 1890, contains many alterations of vital importance to builders and users of steam boilers.

One very important portion of the new law deals with the testing and inspection of plates, and is causing a good deal of anxiety to British firms who make boilers for export to Germany. Hitherto the certificate of the makers has been regarded as sufficient guarantee of the strength of plates, but under the new regulations examination and test must be made by independent experts recognized by the Federal States. At one time it was feared that this would mean that all boilers made for Germany would have to be constructed from steel made and tested in Germany; but representations have been made by the Agricultural Engineers' Association, and it seems not impossible that the German authorities will eventually decide to accept Lloyd's certificates under certain conditions. In any case, it is obvious that the new regulations must result in increased cost and trouble to the British manufacturer and hamper his trade with Germany, and in certain circles it is freely said that that is the intention of the law, and that eventually the Germans intend to prevent altogether the importation of foreign boilers.

Steam boilers are now divided into two classes—land and marine boilers. As the latter are of lesser general importance, most weight is given to the former; and we will confine ourselves to dealing with the alterations which have been made in the laws relating to land boilers.

"Land steam boilers" are held to be such fixed or portable boilers as are not only used on land, but also temporarily on buildings and constructions floating on or moving in water. Hitherto the regulations applied to all closed vessels which were used for generating steam at a higher pressure than the surrounding atmosphere, the only exception being low-pressure boilers, i.e., boilers fitted with a device whereby the steam pressure in the interior of the boiler is prevented from exceeding a surplus pressure of half an atmosphere; these latter are still exempt from the new regulations, and so-called "dwarf boilers" are now also excepted. The latter, in the meaning of the Law, are steam generators whose heating surface does not exceed 1-10 square meter, while the steam pressure must not be more than two atmospheres surplus pressure. They must also be provided with a suitable safety valve. Vessels in which steam taken from another generator is specially heated by the aid of fire (superheaters) are also not subject to the new regulations. Hitherto boilermakers have been left considerable latitude as to the selection of materials and dimensions; the new law, however, makes special provisions as to the stress to which the material is to be subjected, and stipulates for thorough tests of all the materials used in the construction of boilers. If the steam boiler be intended for a working pressure of more than ten atmospheres, no cast iron or malleable cast iron may be used in any part of the boiler walls, while brass is only to be used for fire tubes of not more than 80 mm. diameter outside. Hitherto it has been recommended that the flues of a steam boiler at their highest point should lie at least 10 cm. below the lowest appointed water level, but this distance has now been definitely fixed at 10 cm., and in the case of boilers the water surface of which is 1.3 fold of the total grate area, this distance must be at least 15 cm. As feed devices, two feeders have so far been required which were not dependent upon the same operative mechanism, so that each one could, if necessary, be used for feeding the boiler separately. By the new regulations these devices must be of such a size that each one shall be capable of feeding the boiler with double the quantity of water normally required. In the case of steam feed pumps, driven direct by the main steam engine, one and a-half times the normal evaporating capacity will suffice. Hand-feed pumps are only allowed provided the product of the heating surface in square meters and of the steam pressure in atmospheres, does not exceed 120. One of the stipulated feed devices may be replaced by the direct use of a water pipe, if it be guaranteed that the actual pressure of the water service at the boiler is always at least two atmospheres more than the steam pressure permitted in the boiler. The lowest permissible water level, hitherto shown by a clearly visible mark, must now be marked by the inscription "Niedrigster Wasserstand;" in boilers with a heating surface of less than 25 square meters the letters "N. W." may be used for the same purpose. Fixed and portable boilers must be fitted with at least one



STACK-CENTERING BAR IN PLACE.

and two safety valves respectively, spring and lever and weight valves being both admissible; in the latter case the pressure exerted on each valve must not exceed 600 kilos. The steam space of every boiler must be fitted with a pressure gage, the dial being marked to indicate atmospheres. It must also be provided with a fixed conspicuous mark, clearly showing the maximum steam pressure; the movable indicators hitherto used are no longer allowed.

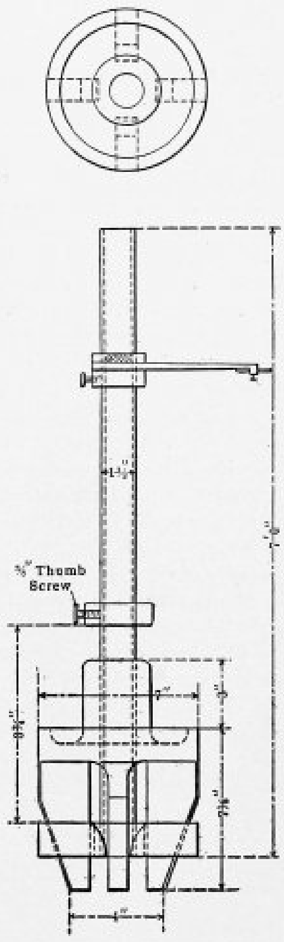
Steam boilers, to be erected at future dates, will not only be examined as to material and strength, but will also be subjected to a thorough internal and external inspection, so as to determine if they have been properly built. The final inspection will be made under steam, and the officials making the trials must use an officially provided double manometer. Boilers for a working pressure of more than six atmospheres, and such in which the product of the heating surface in square meters and of the steam pressure in atmospheres exceeds 30, must not be erected below rooms which are often entered by human beings, nor above any rooms, excepting cellars. This stipulation does not apply to water-tube boilers, the tubes of which are seamless and have a diameter of 100 mm. outside, while the walls of the steam drum are not touched by hot gases. In this case the steam pressure must not exceed six atmospheres.

The new law renders things somewhat easier for so-called "dwarf" boilers, or those in which the product of the heating surface in square meters and the steam pressure in atmospheres does not exceed 2. For these one feed device is sufficient, no second watermark is required, and only one safety valve is necessary.

Boilers already in use and complying with the requirements of the old law, need not be altered to comply with the new stipulations until such time as they need a fresh inspection.—*The Engineer.*

Stack-Centering Bar.

A very convenient apparatus for quickly and accurately centering the stack of a locomotive over the exhaust nozzle is shown in the accompanying illustrations. This device was designed and is in use at the Collinwood shops of the Lake Shore & Michigan Southern Railroad, and consists of a long bar



DETAILS OF CENTERING BAR.

mounted on a base fitted with beveled jaws and a sliding ring, so that it automatically centers itself in the exhaust nozzle tip and simply needs to be set into place to be assured of an accurate location. On the bar is a swinging arm, which can be located at any point, by means of which the stack, after being set into place, can be accurately centered, both at the choke and top.—*American Engineer and Railroad Journal.*

Why the Flues Leaked.

While I am not employed to investigate plants, nevertheless I enjoy visiting plants for my own benefit and information, and with this object in view I recently visited a plant in which the flues in the boilers were a source of constant trouble, so I asked the privilege of making a thorough examination, which was readily granted. After cooling down the boiler I soon noticed just what I had expected. I have found that the overhead feed is not the best way in the world to get water into a boiler.

The pipe was connected up in the ordinary way, with little holes all over it, and where the water had sprayed down over the flues it had formed a solid mass of scale, in fact I could not find the flues on account of the scale, and, of course, these flues leaked. On questioning the man in charge I also found that the boilers were cleaned only once a year. I suggested that he run the feed pipe over the flues and down to the blowoff, so as to let the water feed from below, instead of overhead, which he did. Think of cleaning a boiler only once a year, when, to my notion, it should be done at least once a month!—H. E. Atherton, in *The Southern Engineer.*

A BUTT-STRAPPED JOINT FAILURE.

A boiler rupture of more than usual interest, which, very fortunately, did not result in an explosion, recently occurred at the plant of Hotchkiss Bros. & Company, manufacturers of wood trim, at Torrington, Conn. At 4 o'clock on the afternoon of Sept. 21 the fireman noticed water running down the side of one of the units of a battery of two horizontal-tubular boilers used to operate the mill. The water came from the right-hand side of the shell over the grate at such a rate that the fire was drawn, and by 5 o'clock water had collected to a depth of about 6 inches in the ashpit. The trouble was assumed to be caused by a leak along the calking edge of a seam, and a boiler maker was secured to make the necessary repairs so that the boiler might be put in service the following day; but when the brick covering was removed in the vicinity of the leak it was found that the water came through a crack in the solid plate along the outer row of rivets below the butt-strap of the longitudinal joint, which was triple-riveted. It was decided to abandon the use of the boiler, and a new one was installed in its place. Through the courtesy of W. A. Hotchkiss we were able to take numerous measurements, showing the contour of the shell in the vicinity of the cracked seam, and also of the other seams.

The boiler was built in 1895 by the Cunningham Iron Works, the stamps on all of the shell plates being "Central Iron Works Fire Box Steel, 60,000 T. S., Harrisburg."

The shell, which was made in three courses, was 17 feet 2 inches long over all, and 66 inches inside diameter at the end courses. There were seventy-nine 3.5-inch tubes, 16 feet long, and the bracing above the tubes consisted of five 1.5-inch diameter through rods with upset ends. The boiler was supported on the setting walls by four cast iron brackets, each of these being attached to the shell by six 13/16-inch rivets. The shell and straps were both of 3/8-inch thickness, and the rivets all 13/16 inch in diameter, pitched about 6 7/16 on the

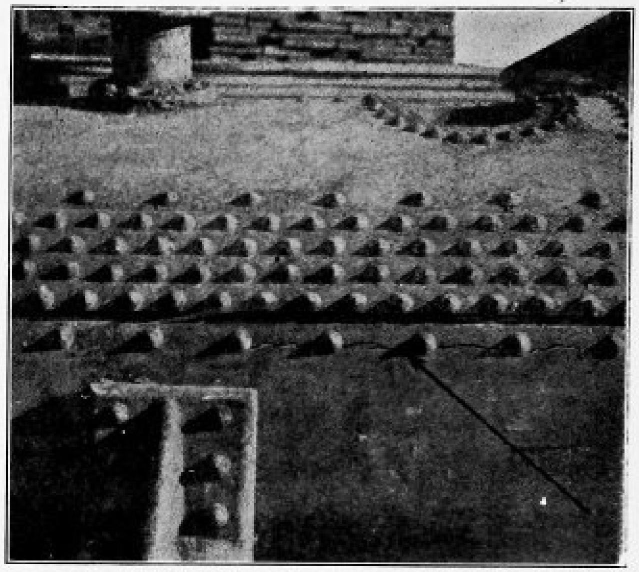


FIG. 1.—THE 23-INCH CRACK.

outer rows and 37/32 on the inner rows. Fig. 2 shows the dimensions of straps and the spacing of rivets, also the location of the crack, which is also illustrated in Fig. 1. The length of the rupture was 23 inches, and it commenced 7⅛ inches in front of the line of girth rivets connecting the front and center courses, and extended toward the front from this point. The crack was not in one continuous line but had a break near the center of its length, the ends of the crack at this point overlapping each other, as shown in Fig. 1.

While the formation of this crack had probably extended over a long period of time, the final breaking through was very sudden, as evidenced by the severe leaking, caused at once by the failure. The contour of the shell was measured in the planes marked 1 to 8 in Fig. 4, the positions of points 1 to 4

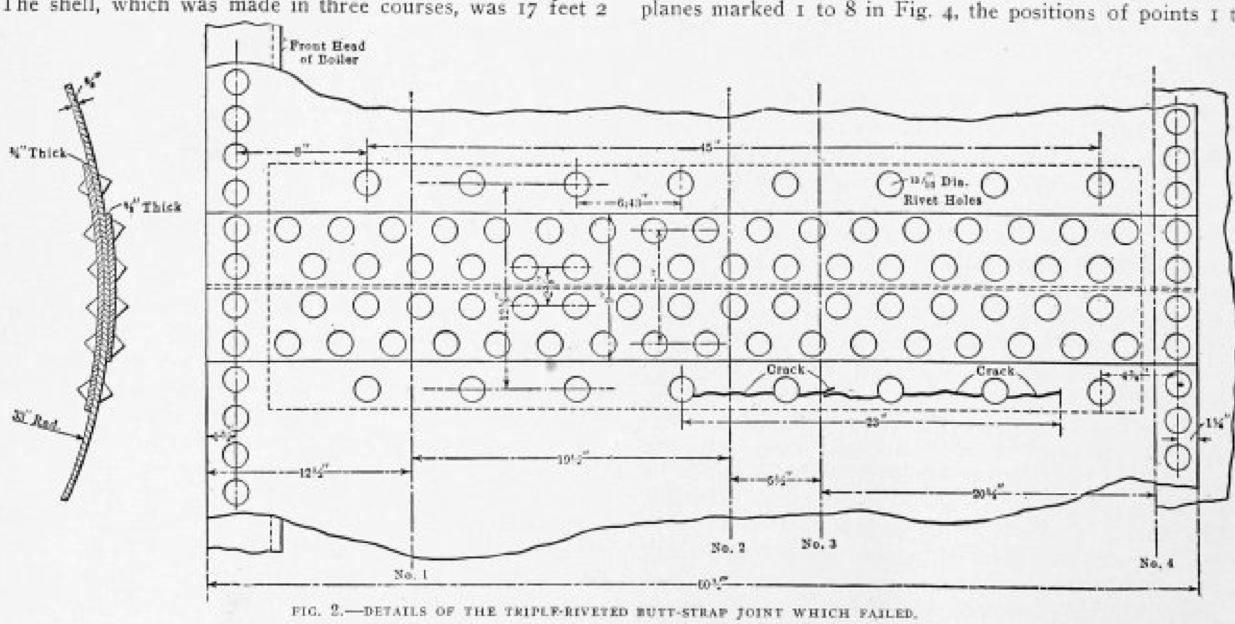


FIG. 2.—DETAILS OF THE TRIPLE-RIVETED BUTT-STRAP JOINT WHICH FAILED.

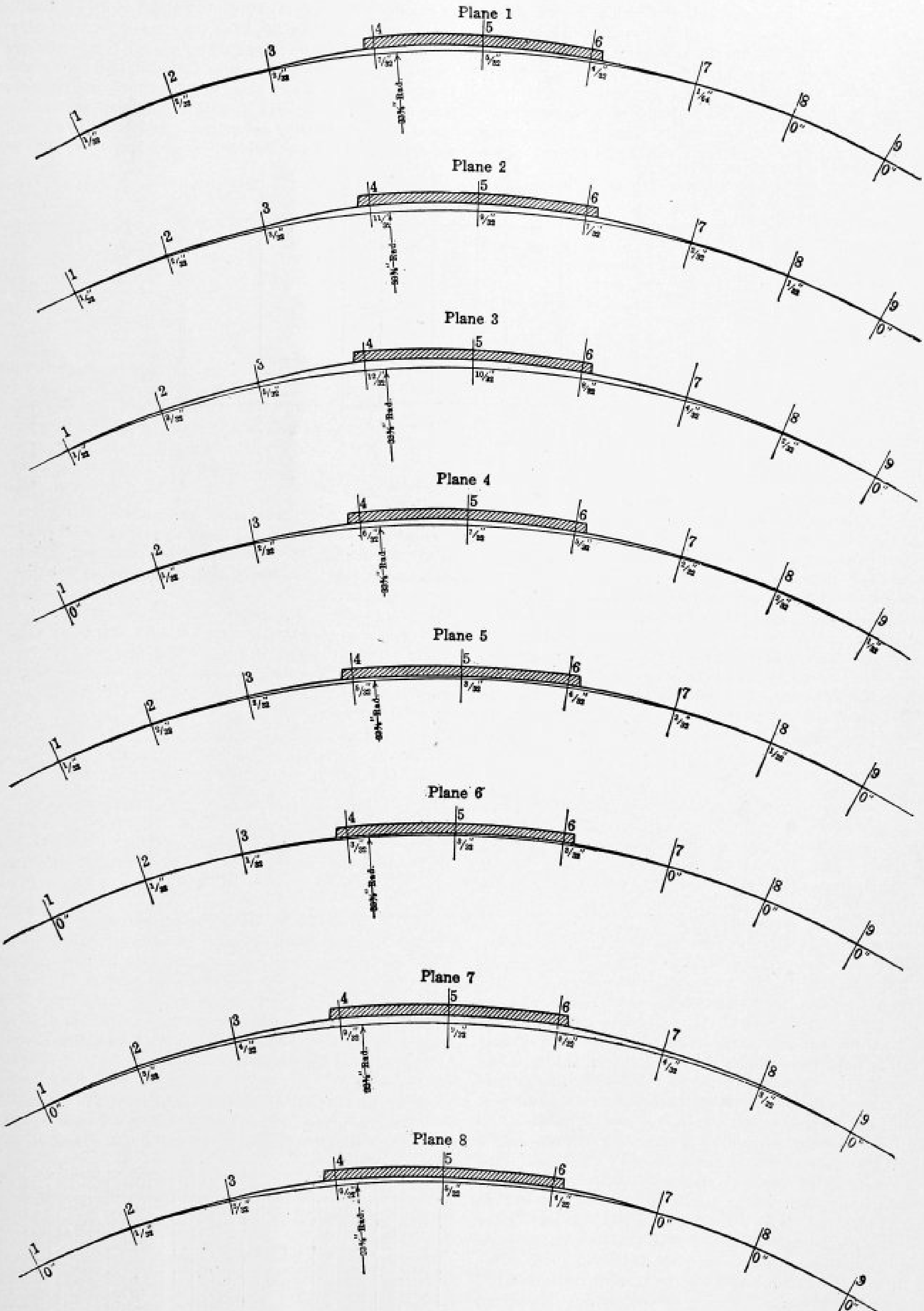


FIG. 3.—DEPARTURES FROM CIRCULAR SECTIONS MEASURED ON PLANES INDICATED ON FIG. 4.

on the front course being also indicated in Fig. 2. The points on the front course were selected at irregular distances, as shown, on account of the interference of nozzle, manhole and bracket with more evenly spaced positions. Point 7 was selected on the rear course because it represented the point of maximum divergence from a true cylinder on this course.

The method used for measuring the contour at the several points involved the use of a form, consisting of a board, which had ends about 4 inches long, sawed to a radius of 33⅜ inches, this being the radius of the outside of the cracked course. Between these ends a curve of 35 inches radius was accurately cut, and the distance between this curve and the shell was measured with inside calipers. The board form actually used to take the measurements with, however, was of much greater length than that shown in this view. The dimensions of the board form are given in Fig. 5, the points marked 1 to 9 in this figure corresponding to the similarly numbered points in Fig. 3. Notwithstanding the fact that this form spanned about 36 inches of the circumference of the shell, it was not long enough to reach entirely over the distorted portion adjacent to the seam. This is shown by the fact that some of the contours in Fig. 3 commence with deviations of 1/32 of an inch instead of with zero, as they would have done if the shell had been true to form at the points where the board templet rested upon it. Fig. 3 shows the contour of the shell across the joints, true to scale in the respective planes indicated in Fig. 4. To ascertain if the shell was generally out of round, numerous measurements were made on different portions of all courses away from the seams, and at none of these points was the shell found to deviate more than 1/32 of an inch from a true cylinder. It will be noted in Fig. 3 that the greatest variation from a true cylindrical form is in the plane 3-3, of Fig. 4, which is nearest the center of the crack.

While the seam on the rear course is very much out of true, as shown by the contours at points 7 and 8 of Fig. 3, it will be noted that it is not one-sided like the seam of the front course, but that the deviations from a true circle are symmetrical with respect to the strap. The extreme variation, as shown in plane 7, was confined to a very short length of shell, not more than 7 or 8 inches long. The fact that the joint on the front course was considerably out of true could be noted by sighting along the shell just below the outer butt strap, the shell showing a decided hump about the middle of the crack.

This boiler had been in use about 13 years at a pressure of 90 to 100 pounds. The efficiency of the seam was 87½ per cent, and, using the stamped tensile strength as a basis of calculation, the shell had a factor of safety of practically six when carrying 100 pounds pressure, so the cracking of this sheet cannot be attributed to undue strain. This is the second failure in New England of a butted and strapped joint which has come to our knowledge in about one year's time.—*Power and the Engineer.*

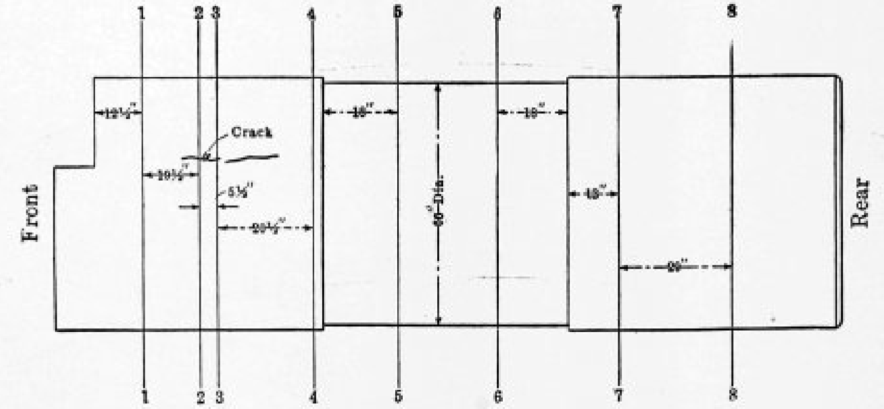


FIG. 4.—SHOWING LOCATION OF PLANES IN WHICH THE DISTORTIONS WERE MEASURED.

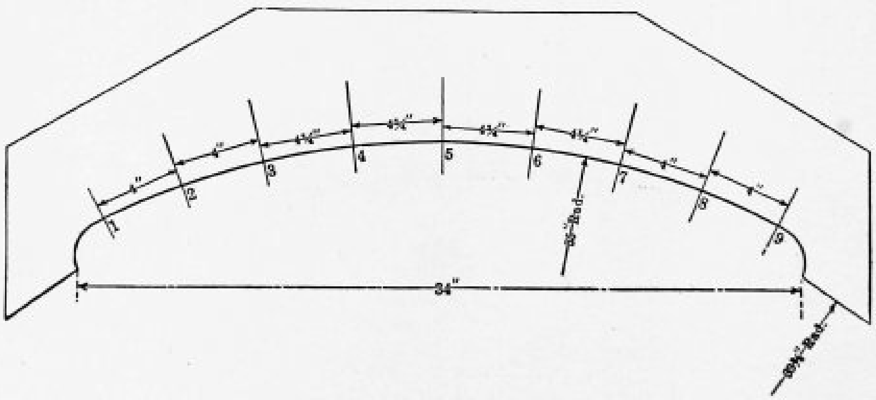


FIG. 5.—DETAILS OF FORM FOR MEASURING DISTORTION.

A USEFUL TABLE FOR A LAYEROUT.

BY FRANK T. SAXE.

One of the most useful tables for a layerout, and one that is used practically every day by the writer, is the table of sines below for finding the length of the chords from three to 100:

3	.86603	17	.18375	31	.10117	45	.069756	59	.053222	73	.043022	87	.036103
4	.70711	18	.17365	32	.098018	46	.068243	60	.052336	74	.042441	88	.035692
5	.58779	19	.16460	33	.095056	47	.066793	61	.051478	75	.041875	89	.035291
6	.50000	20	.15643	34	.092269	48	.065401	62	.050649	76	.041325	90	.034899
7	.43388	21	.14904	35	.089640	49	.064073	63	.049845	77	.040788	91	.034516
8	.38268	22	.14232	36	.087156	50	.062791	64	.049068	78	.040267	92	.034141
9	.34302	23	.13617	37	.084804	51	.061560	65	.048312	79	.039756	93	.033774
10	.30902	24	.13053	38	.082580	52	.060379	66	.047582	80	.039260	94	.033415
11	.28173	25	.12533	39	.080466	53	.059240	67	.046872	81	.038775	95	.033064
12	.25882	26	.12054	40	.078460	54	.058145	68	.046184	82	.038303	96	.032719
13	.23932	27	.11609	41	.076549	55	.057090	69	.045515	83	.037841	97	.032381
14	.22252	28	.11197	42	.074731	56	.056071	70	.044865	84	.037391	98	.032051
15	.20791	29	.10812	43	.072995	57	.055089	71	.044232	85	.036954	99	.031728
16	.19509	30	.10453	44	.071339	58	.054139	72	.043619	86	.036522	100	.031411

Rule: Multiplying the diameter by the sine equals the chord.

Example: In Fig. 1 let it be required to find the length of the chord of the arc *AB*, which contains 120 degrees. Since

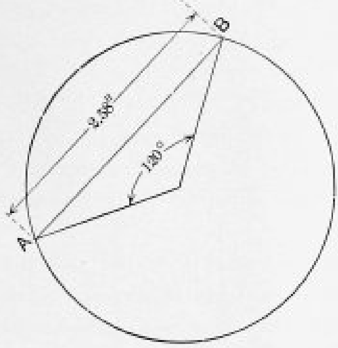


FIG. 1.

there are 360 degrees in a circle, the chord divides the circle into three equal parts. Now, by referring to the table, we find the figures opposite 3 to be .86603. Now, assuming the diameter to be 3 inches, we multiply .86603 by 3, which gives us 2.57809 the length of the chord as 2.58 inches.

Then, again, let it be required to find the diagonal of a square, as in Fig. 2, by adding the legs together and multiply-

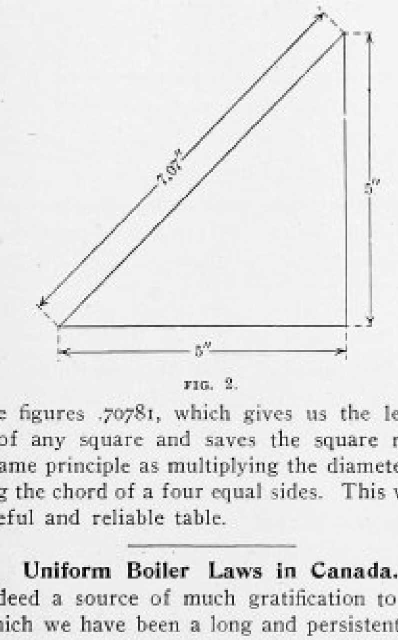


FIG. 2.

ing by the figures .70781, which gives us the length of the diagonal of any square and saves the square root method. It is the same principle as multiplying the diameter of a circle and finding the chord of a four equal sides. This will be found a very useful and reliable table.

Uniform Boiler Laws in Canada.

It is indeed a source of much gratification to us that the step of which we have been a long and persistent advocate is at last within measurable distance of realization. We refer to the matter of a uniform boiler law for the Dominion. This has been the theme of many an editorial in the *Engineering Journal,* and we have repeatedly emphasized the disadvantages and disabilities which separate and distinct provincial laws impose upon both manufacturer and engineer. As matters stand just at present each Province of the Dominion has its own self-centered laws regulating the construction of boilers and the qualifications requisite for admission to the engineering profession. The handicap under which the inter-provincial relations of engineer and manufacturer labor from this state of affairs is obvious, and the surprising fact to us is that some organized move to have matters remedied was not made long ago. The substitution of a uniform boiler law for the present state of separate and distinctive regulations for each Province will be a great relief for the engineer. As matters stand at present the engineer is practically disbarred from practicing in any other than the Province in which his license is issued. If he removes from one Province to another, his existing certificate becomes a dead letter, and he has no other alternative than to qualify for a new license under new regulations. It is scarcely necessary for us to say that this condition of affairs is absurd, and the fact that it has not been more strongly attacked in the past is due to lack of united action on the part of engineering authorities all over the Dominion. From the point of view of the manufacturer the consummation of a uniform boiler law is equally desirable and urgent. At present he has to provide a boiler differing much in details for each Province. The loss of economy which necessarily results is evident. As one manufacturer puts it, "It is playing havoc with our trade, and it requires us to keep an additional thickness and quality of goods to suit these different purposes." British Columbia, Saskatchewan, Alberta, Quebec, Ontario, Manitoba, and even the City of Montreal, have diverse and distinct boiler inspection regulations, all calling for some detail of construction peculiar to each individual Province. There is really no valid reason why this deplorable condition of things should prevail. Petty considerations and virtual inaction on the part of manufacturers' associations and engineering societies are to a large extent responsible for their continued existence.

The present effort, which has taken the shape of an interprovincial conference at Regina, is due, in a large degree, to Mr. J. W. Harkom, who represented the Canadian Manufacturers' Association at the gathering. The British Columbian representative was Mr. J. Peck, chief inspector of steam boilers and machinery for that Province. The views of Ontario engineers were expressed by Mr. Duncan Metcalf, chief mechanical engineer for the Province. These men are thoroughly conversant with the situation, and as a result of the allied deliberations and engineers, an act, adapted to the interests of all the Provinces, has been prepared, and will be presented to each Provincial government for ratification. There is every prospect that this move will be successful, and all concerned can look forward with confidence to the disappearance, at no far distant date, of the present anomalous and inimical condition of affairs.—*The Engineering Journal of Canada.*

In his forthcoming report, J. D. Beck, Commissioner of Labor and Vital Statistics, devotes several chapters to the subject of boiler inspection and the need of legislation respecting steam boilers. In Wisconsin, according to the last factory inspector's report, there were 2,485 firms using steam power. The number of boilers in use was 5,103, and the horsepower of the same was 478,941. There is no State law requiring any inspection or examination except the power that is granted to City Councils by chapter 925, "To provide for the inspection and regulation of stationary steam engines and boilers." No city has taken advantage of this right, and the boilers in this State remain uninspected unless insured by some casualty company.

Section 4,358 provides that "Any one having charge of any steamboat or railroad train or any other apparatus for the generation of steam, who shall, by ignorance or gross neglect, or for the purpose of excelling in speed, cause a collision or wreck, or create, or allow to be created, such an undue quantity of steam as to burst or break the boiler, or other apparatus in which it shall be generated, by which any person shall be killed, shall be deemed guilty of manslaughter in the third degree."

Commissioner Beck has prepared a table covering a period of seventeen years, and showing the number of boiler accidents in Wisconsin in that time and the number of persons killed or injured. The table shows a remarkable increase in the number during the earlier years of the period up to 1895, and the following total results: Number of accidents, 145; persons killed, 84; persons injured, 163.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Tendencies in Boiler Design.

After discussing certain defects in the design of a stationary boiler recently built for a particular purpose, an eminent engineer expressed surprise that any one should to-day take the trouble to design a new boiler. So many thousands of boilers have been designed and built on standard lines which have given satisfaction, and the performance of which can be relied upon with certainty, that it seemed to him futile to attempt anything new and untried. We believe that there is much truth in this observation. Although steam boiler practice is unsatisfactory in many respects, yet it cannot be said that there are not a sufficient number of standard designs to meet almost every requirement which might come up. Progress in the design of stationary boilers has of late been slow, and most of the construction has been confined to standard types. Improvements have been confined largely to minor details in the construction of watertube boilers.

In the railroad field, however, the past year has brought about a marked change in design, and new features have been introduced which mean much in the development of the locomotive and of steam transportation. The principal feature of locomotive development during the past year has been the construction of a large number of Mallet articulated compound locomotives, which have been of enormous size and weight. This type of locomotive was introduced primarily for freight work, but it is now being appropriated for passenger service. The largest one built during the year weighed 462,450 pounds. These locomotives, with their exceptional length, have introduced a length of boiler barrel which is unprecedented, and which is more than can be utilized simply for the boiler itself. This exceptional length has induced a return to combustion chambers, and has introduced feed-water heaters and given additional space for superheaters. The feed-water heater is a comparatively new introduction, and its usefulness remains to be proved, although theoretically it should be of great benefit. Practice in the use of superheated steam has become so general that most of the early difficulties are fast being overcome, and locomotive boilers with superheaters are no longer novelties.

No startling developments can be said to have occurred recently in the construction of marine boilers. The general tendency in design has been towards higher pressures, larger boilers, larger combustion chambers and better proportions of heating surface. The increase in pressure has naturally necessitated the use of a better grade of material and the highest class workmanship. Steel boiler plates of immense size are now handled with ease by modern machinery, and 1⅝-inch rivets are driven as easily as ¾-inch rivets formerly were.

One thing which will probably before long have a great influence on steam boiler construction is the development of autogenous welding. This has all come about in the last few years, and particularly during the year just past. As yet its use in boiler work is confined to repair work, and little dependence is placed on it for important joints. This, however, is the most radical and promising improvement which has been introducted in the boiler shop for a good many years, and it will undoubtedly in time justify itself and become universally applied.

Power Transmission in a Modern Boiler Shop.

Our leading article this month calls attention to the important points in the construction and arrangement of a modern boiler shop. Compared with other factories and manufacturing plants a boiler shop is far less complicated, but, although the number of tools and machines used, and the number of operations performed in building a boiler are not as great as in other lines of manufacture, yet they are all so closely related and inter-dependent that the arrangement of the shop, the location of the machine tools and the provisions for handling material can greatly hinder or facilitate the work. Since the construction of a boiler involves the handling of heavy weights, it is of first importance that every shop should be so arranged that the work will progress systematically through the shop, entailing the least amount of handling. For this reason it is usually found economical to install the most up-to-date and complete system of traveling cranes and other appliances for handling materials which can be devised. Next to this the most important problem is the question of power transmission. This is such an important question that we intend to present in future issues a complete discussion of it, considering the question from every point of view, and we trust that any of our readers whose experience has led them to form valuable conclusions respecting the best form of power transmission for a boiler shop will favor us with their comment as these articles appear.

COMMUNICATIONS.

Cause of the Bagged Patch.

EDITOR THE BOILER MAKER:

Replying to the query on page 355 of your December number, regarding the cause for the bagging of a patch on a boiler built twenty years ago, evidently the boiler was built of iron and the patch used was made of steel. The trouble is undoubtedly due to the unequal expansion of the two metals—a trouble which we almost inevitably find where two grades of metal are used together. M. F. A.

Portsmouth, Va.

Triangulation.

EDITOR THE BOILER MAKER:

In your December issue appears a communication from Mr. I. J. Haddon, Cardiff, Wales, in which he condemns the method of triangulation for developing curved surfaces. Since there are hundreds of practical men using triangulation with marked success, apprentices and others who do not understand laying out by triangulation should not give Mr. Haddon's remarks any consideration. When it comes to "hair splitting propositions" nearly everything can be shown to be more or less incorrect theoretically, but nowadays the wide-awake person uses methods that are short, and at the same time sufficiently accurate for all practical purposes.

H. S. JEFFERY.

EDITOR THE BOILER MAKER:

I have read with great interest Mr. Haddon's remarks upon the subject of triangulation in your December issue, and I greatly appreciate the opportunity to comment upon his discourse, as well as to defend the principles of a system which has proved, in the extreme, both reliable and practical within the bounds of good work. I am positive every artisan or mechanic acquainted with the results, as obtained from development by triangulation, is satisfied in his own mind that this approximate method is sufficiently accurate to meet any condition or construction that may be encountered in the boiler shop. This is an assured fact, since practical experience has proved it in both Europe and America. The writer wishes to assure Mr. Haddon that the American mechanic appreciates the fact that a small discrepancy does arise in using this method, and that he has been aware of it for years, and in connection with this he is also willing to embrace a more practical system of development if such a thing could be brought about. This has been tried and tried again, but to no avail. Now Mr. Haddon has come to the front and given us some food for thought; but, alas! after a careful consideration and study of the fundamental principles, as outlined in his system, we can come to only this conclusion—that the trangulation method still stands pat in all its phases.

He has given us a method which involves a greater amount of complexity, owing to the different number of times that measurements and lines must be transferred from one view to another. Errors are sure to creep in where this procedure is necessary, and if great care is not exercised his approximate method will not meet within as close a margin of accuracy as triangulation.

Conditions in this country require that work must be turned out within a certain limit of time, and in the rush for output we certainly would not have time to "hem and haw" about a few inaccuracies, which could only be measured with a vernier, micrometer or some other device. This is an age of advancement and hustle, and to "get there" frequently requires both approximate and rule of thumb methods.

There are a great many principles which work out very nicely upon paper, but when placed in practice it will be found that they do not meet with the requirements. Now, this is just the case with Mr. Haddon's system. His development and arguments look super-substantial, but it will be found that they do not meet all the conditions encountered. As an example, we will refer to his development for the base connection. Supposing the minor diameter of the top connection or ellipse in the case is made nearly equal to the major diameter, then if the elements of the transition piece are extended they will not meet the vertical line 12-2, even within the limits of the shop or a 40-acre field. Consequently, it is obvious that other methods of development must be used.

Mr. Haddon's comments, in my estimation, are not based upon practical experience with triangulation. This does not mean that he does not understand developments along the line as outlined in his paper, as I firmly believe he does; but it is evident from his comments that he is not thoroughly conversant with the principles in question and their application. If he were, I am sure that practice would have proved to him that it is unnecessary to find fault with such a reliable system of laying out as the "Method of Triangulation."

He points out very clearly that it should be the aim in layouts to have straight lines in the plan and elevation, and these lines should become rolling lines in the development. This should always be so if conditions permit; but, as pointed out previously, there are numerous problems encountered, especially in tapering forms, which cannot be laid out in that manner without a great deal of extra work, which would also involve a greater amount of space than may be had within the limits of the average shop. Mr. Haddon can rest assured that if he encounters such conditions he will have to devise means of development other than the method of tangents and crossing planes to meet the requirements, and I am positive in stating that if he applies the method of triangulation he will find it accurate, reliable and beneficial, as it will will bring out a pattern which is sufficient for practical purposes.

Scranton, Pa. C. B. LINSTROM.

EDITOR THE BOILER MAKER:

I read with interest Mr. I. J. Haddon's communication in your December issue on laying out by triangulation, also his condemnation of same. I am an advocate of triangulation when used in the right place, and therefore take exception to Mr. Haddon's claims.

I agree with Mr. Haddon to a limited extent; that is, that the rule should not be applied to problems that can be worked out by parallel lines or radial lines. Apparently Mr. Haddon's only objection to triangulation is that the dotted lines forming the triangles are curved lines, which appears to be very true until the situation is carefully studied.

I am inclined to believe that our correspondent has this dotted or imaginary line pictured in the wrong light, in that he claims that it is a curved line. I claim that the dotted line or imaginary line in a diagram constructed for the development of some irregular shape does not possess any curvature in the least. But that the curve takes place when the pattern is rolled, which does not conflict whatever in the developing of the pattern. See Figs. 1 and 2. These are the profile and elevation of a cone, showing the lines as would be necessary should the article be laid out by triangulation. I have filled the semi-circle out with dotted and solid lines, whereas but one of each is necessary. I do not advocate the rule for laying out a cone but merely as an illustration.

The full lines *S P* are the rolling lines. The accuracy of same are not disputed. The dotted line *A B* is the main issue. Now, *A B* is a straight line drawn from point *P* in the small diameter diagongally across to point P in the large diameter of the cone. This is a straight line whose true length is shown in Fig. 3, as well as the true length of the solid line P P.

Where the pattern is laid out we still maintain the straight dotted line. But when the pattern is rolled parallel with the rolling lines the rolls pass diagonally over the dotted lines, as shown by the arrow point, Fig. 1, consequently curving it slightly. X X, Fig. 2, shows the dotted line in the elevation as it would appear as imaginary. C C shows the same line, marked on the flat sheet, rolled to a cone.

Here is where Mr. Haddon arrived at the idea of the dotted line being a curved line. However, this does not interfere with the development of the pattern, as this change makes its appearance after the object is formed. The reader may think that the fact that the dotted lines curve when the pattern is

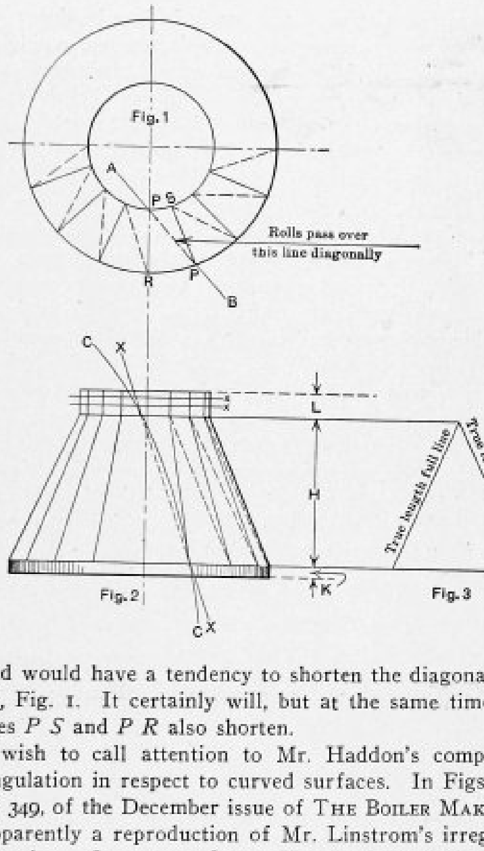


Fig. 2 Fig. 3

rolled would have a tendency to shorten the diagonal distance P P, Fig. 1. It certainly will, but at the same time the distances P S and P R also shorten.

I wish to call attention to Mr. Haddon's comparison of triangulation in respect to curved surfaces. In Figs. 2 and 3, page 349, of the December issue of THE BOILER MAKER, Fig. 2 is apparently a reproduction of Mr. Linstrom's irregular pipe connection. On page 348 Mr. Haddon says in part: "You will notice a dotted line in Fig. 2. This has been shown in the development so as to prove that triangulation, in respect to curved surfaces, is not a reliable method, for with C, Fig. 3, as a center, and C D, Fig. 2, as a radius, describe an arc, as shown in Fig. 3. Now, if triangulation were accurate the arc drawn across the center of the hole at D, Fig. 3, whereas it is inside the hole. Again, had the dotted line been drawn from B to E it would be found that the arc drawn in the development would be inside the hole E. Therefore it does not matter which way you may draw the dotted lines to form triangles, they can never be correct in respect to curved surfaces.

"The reason is because the dotted line forming the triangle in the elevation, Fig. 2, is in reality a curved line, and in the development this extra length is not taken into account, and it would be rather difficult to do so. Hence the inaccuracies. I think I have said sufficient to stop anyone ever using triangulation again in respect to curved surfaces and saying they have made accurate work."

If the reader will glance at Figs. 2 and 3 of Mr. Haddon's article on page 349 of the December issue, he will be convinced that Mr. Haddon is radically wrong. Therein he has merely drawn the dotted line C D, Fig. 2, and has taken this as the true length of the dotted line. This, however, is incorrect. So our correspondent's claim as to the inaccuracy of triangulation remains to be proved.

To determine the true length of the line in question it will be necessary to construct a right triangle whose base is equal to the length of one of the spaces in the semi-circle in Fig. 2, and whose height is equal to the length of D E in the same figure. The hypotenuse will then be the length of the dotted line. It will be found that the length of the dotted line will be equal to that of C D, Fig. 3.

It is evident that our friend has failed to prove that triangulation in respect to curved surfaces is not a reliable method to use in developing irregular surfaces, for he has failed in the very point aimed at in Figs. 2 and 3. I do not wish to belittle Mr. Haddon in any way, for I believe him a man of high attainments, and has the credit, I believe, of being the first one to offer as a substitute for triangulation a method which apparently is very accurate. My opinion is that the practice of laying out by triangulation will never be abandoned, because the method is quite lucid and accurate and can be handled on a limited surface, and is applicable to any shaped figure. Besides, the length of the angles may be determined by figures on the drawing board, which is a great advantage, for a very large sheet can be laid out in the drafting room. However, I am glad to know of a rule other than triangulation, for we will have a rule to use as a check on a pattern developed by triangulation, whereas before if the layer-out went astray with the contour of the sheet, especially a new form, he would not detect the mistake until too late. Then, too, as there were no means available to check the pattern up he would have to run the risk. I dare say many patterns have been laid out by triangulation that looked all right, but later it was found that a mistake had been made. So here, in some cases, we are in need of a rule to check by.

I suppose Mr. Haddon was a little hasty in his note regarding the rivet lines of his pattern being the same as the bevel or rake line. In some cases it is all right to space the rivets on the curve lines, but in other cases not. Suppose Fig. 2 is a very heavy piece of work which requires double riveting and 1-inch rivets. The distance H would be the flanging line, and L would be the flange and X X the rivet lines. I would like to have Mr. Haddon develop the frustum of a cone cut off at an angle by his method, describing same in a future issue of THE BOILER MAKER. J. N. HELTZEL.

PERSONAL.

A. THOMPSON, formerly assistant foreman of the A. G. S. Railway, has resigned to become foreman of the Birmingham Southern shops at Pratt City, Ala.

JAMES KING, for the past three years foreman boiler maker at the Nichols & Langworthy Machine Shops, Hope Valley, R. I., has returned to Paterson, N. J., and is connected with the East Jersey Pipe Company. Mr. King was foreman boiler maker at the Rogers Works of the American Locomotive Company in Paterson for a number of years.

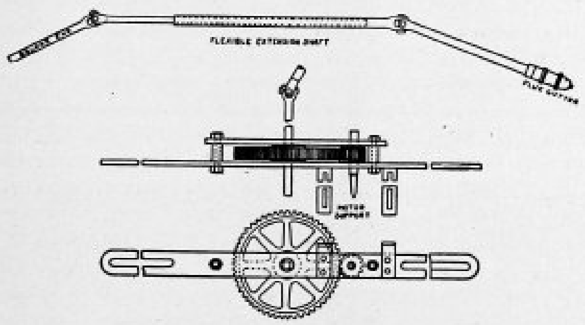
H. F. HUMBEL, head of the boiler shop and structural department of the Columbia Chemical Company, Barberton, Ohio, spent the Christmas holidays visiting friends and relatives in Cleveland, Ohio, which was his former home.

H. S. JEFFERY, who is well known to boiler makers through his connection with the course of instruction for boiler makers at the International Correspondence School, Scranton, Pa., and from his numerous articles on the subject of boiler making in the technical press, became associated with the bond house of J. S. & W. S. Kuhn, Inc., of Pittsburg, Pa., on Jan. 1, with headquarters at Richmond, Va.

ENGINEERING SPECIALTIES.

A Locomotive Flue Cutter.

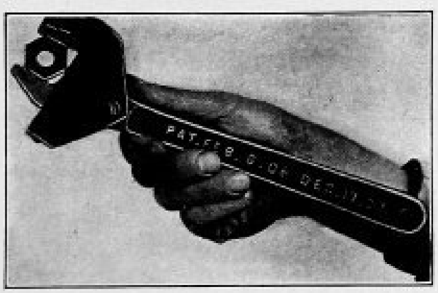
The Scully Steel & Iron Company, Chicago, Ill., has placed on the market a new tool for cutting tubes out of locomotives, known as the Scully railroad cutter. It is intended to be operated in connection with the cross bars and gearing to suspend the motor. The motor runs continuously, for the reason that the flue-cutter knife does not cut the tube until the operator starts it with his thumb. It is claimed that the blade cuts



the flue in one and one-third revolutions. Then the knife automatically springs back to its first position, and does not cut until the operator removes the tool, places it in the next flue and again starts the knife with his thumb. It is therefore claimed that the machine is a very safe and rapid one to handle; in fact, the manufacturers claim that the tool will pay for itself in from thirty to sixty days on account of the saving in labor which it effects.

A New Automatic Wrench.

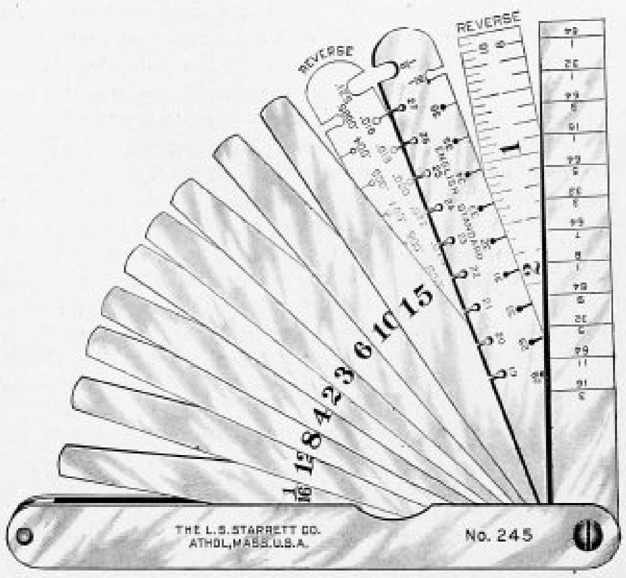
The Webb & Hildreth Manufacturing Company, 9 Forest street, Gloversville, N. Y., recently placed on the market a new type of automatic wrench, which can be quickly adjusted for



use on pipe, nuts, lag screws, etc. As shown by the illustration the wrench is simply constructed and convenient to handle. It is claimed the wrench is perfectly reliable.

An Engineer's Taper, Wire or Thickness Gage.

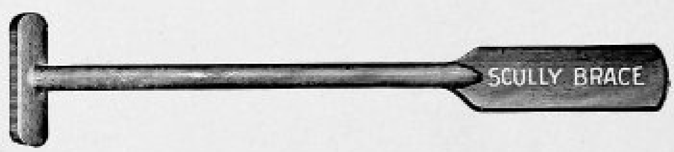
The L. S. Starrett Company, Athol, Mass., has placed on the market a useful set of gages in compact form. The set includes taper, wire and thickness gages, all of which may be closed up and easily carried about. The taper gage shows the thickness in sixty-fourths up to three-sixteenths inch on one side, while the reverse side is graduated, as a rule, 3 inches of its length, reading in eighths and sixteenths of an inch. The



wire gage, English standard, shows on one side sizes numbering from 19 to 16, with two extra slots, one 1/16 the other ⅛ inch, and on the reverse side shows the decimal equivalents expressed in thousandths. This gage has also nine thicknesses, or feeler gage leaves, approximately 4 inches long, of the following thicknesses: .002, .003, .004, .006, .008, .010, .012, .015 and 1/16 inch, all of which can be folded within the case, which is 4¾ inches long, convenient to handle or to carry in the pocket.

A Weldless Steel Boiler Brace.

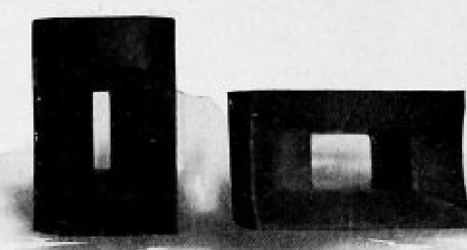
The Scully weldless steel boiler brace, placed on the market by the Scully Steel & Iron Company, Chicago, Ill., is made from one piece of open-hearth steel of from 55,000 to 60,000 pounds per square inch tensile strength. The area of the metal is so distributed that after the rivet holes are punched



it is claimed that the strength of the brace is practically the same at all points, the head and shell end being a little stronger than the body, which being of round steel of a known tensile strength can be readily estimated for strength. The ends are upset and forged solid with no welds. It is claimed that this brace is cheaper, stronger and better than a pressed steel or welded brace.

Vanadium Steel Dies for Hot Forging and Drawing Work.

A customer of the Pennsylvania Forge Company, Philadelphia, Pa., was using carbon dies on very severe service for



hot forging and drawing work. These dies were giving an average service of two days, and breaking from crystallization and other defects in the steel. They decided to try vanadium steel in the hope that the remarkable properties of vanadium in retarding or eliminating crystallization would give the dies a longer period of usefulness; some vanadium steel was purchased from the Bethlehem Steel Company, and the dies shown in the illustration were made therefrom. We have been advised by the Pennsylvania Forge Company that the dies were used in the same manner, by the same man, on the same machine and for the same service as the carbon dies, and at the time of writing us had been in use for over four months; the illustration is made from a photograph of the dies at the time the letter was written.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

934,623. WATER-GAGE. CALVIN M. O'DANIELS, OF SEATTLE, WASH.

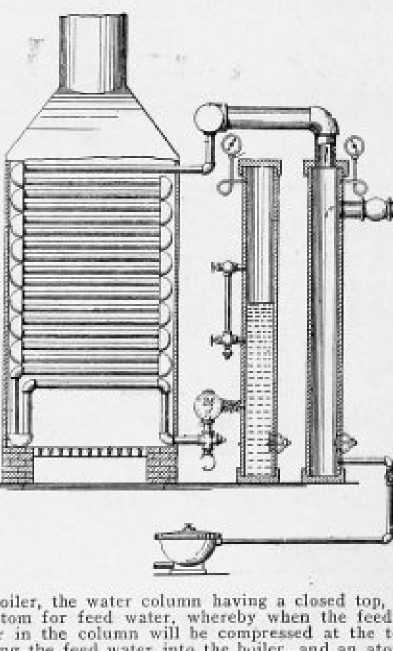
Claim 1.—A gage comprising a frame consisting of upper and lower substantially triangular heads and corner bars connecting the same, said corner bars of the frame being spaced to provide legs forming the water chamber of the gage and each having its inner face inclined in relatively opposite directions, and glass panels secured to said frame and extending over the spaces between the corner bars thereof. Two claims.

932,440. STEAM BOILER FURNACE. DANIEL L. BROWNFIELD, OF FARMER, WASH.

Claim 2.—The combination with an upright fire tube boiler, of a firebox thereunder having an extension in front of the boiler shell and above the top sheet, a baffle plate extending across the fire-box below the top sheet and the tube inlets and projecting forwardly and upwardly from the rear wall of the fire-box and into the extension, and a grate below the baffle plate. Two claims.

932,445. BOILER. CHARLES EDWARD CHAPMAN, OF FORT EDWARD, N. Y., ASSIGNOR OF ONE-HALF TO JOSEPH GOODFELLOW, OF FORT EDWARD, N. Y.

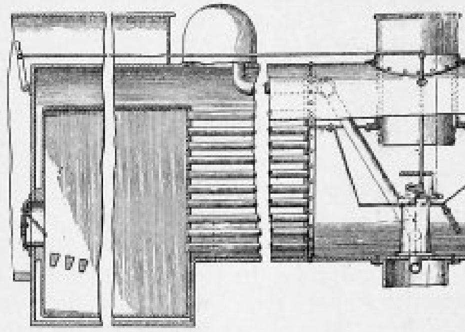
Claim 1.—In a tubular boiler composed of a plurality of coils, a water column removed from the body of the boiler, a water drum between the water column and the boiler, a connection leading from the bottom of the column to the drum, connections leading from the drum to the



coils of the boiler, the water column having a closed top, and an opening at its bottom for feed water, whereby when the feed water is admitted the air in the column will be compressed at the top thereof to assist in forcing the feed water into the boiler, and an atomizer in each of the connections between the drum and the coils. Four claims.

932,595. FURNACE. WILLIAM T. SUMMERS, OF CHICAGO, ILL.

Claim 1.—The combination with a furnace having a smoke-box or compartment, of a stack leading therefrom, an exhaust-nozzle located below the lower end of the stack and contracted at its upper portion, an upwardly contracted nipple mounted on the upper portion of the exhaust-nozzle, a partition located in the nozzle and extended from its lower portion upwardly, a skeleton-frame bridge pivotally mounted near the upper end of the nipple and adapted to move in a horizontal plane over the top thereof and consisting of a series of radially disposed members, means to operate said bridge, and a blower arranged between the



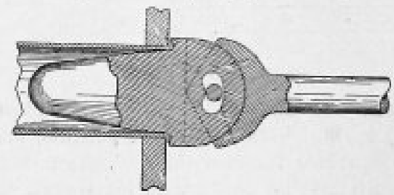
lower end of the stack and the top of the nipple and being provided with a substantially circular horizontal portion closed at one end and provided with a series of steam ports in its upper surface. Two claims.

932,777. BOILER-FEED AND WATER-HEATER. DANIEL GOFF, OF MILLVILLE, N. J.

Claim 1.—In a device of the character described, a boiler, a water tank, a plurality of cylinders, one of the cylinders being movable, means for conducting water alternately into one or the other of said cylinders, means for conducting steam from the boiler alternately into one or the other of said cylinders, for forcing the water therefrom into the boiler, and means controlled by the movable cylinder for directing the exhaust steam from said cylinders into said water tank to assist in forcing the water therefrom. Seventeen claims.

933,707. COMBINED FLUE BEADER AND EXPANDER. THOMAS H. HAYES, OF DENVER, COL.

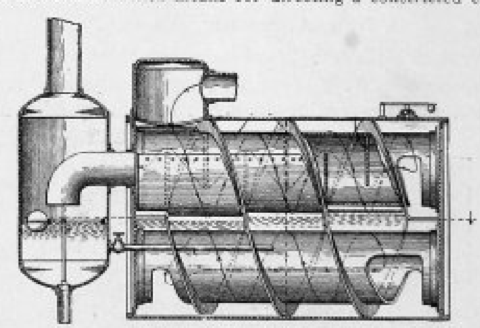
Claim 1.—A flue beader comprising a beading member and a handle member, one of the said members having a lug and the other a grooved head to receive the lug, one of the said parts having a convexly curved



edge, and the other a concave shoulder engaging the said edge, and a pin loosely connecting the head and lug, one of which has a curved slot through which the pin passes and the other an opening in which the pin is fitted. Seven claims.

938,356. STEAM EQUALIZER. HENRY H. WAIT, OF CHICAGO, ILL.

Claim 3.—In a steam equalizer, containing a body of heat-retaining fluid, the combination with means for directing a constricted current of



steam into frictional contact with the free surface of such fluid, or directing means for said fluid adapted to cause the portions receiving the steam impact to flow toward the cooler portions of the body and thence to return to the place of impact. Nineteen claims.

930,313. FUEL FEEDER. WILLIAM H. HARDING, OF PHILADELPHIA, AND CHARLES M. SAEGER, OF ALLENTOWN, PA.

Claim 1.—A fuel feeder provided with means for establishing a stream consisting of a mixture of air and powdered fuel and with a plurality of straight tubes and having, intermediate of the tubes and means, an expanded mixing chamber communicating with the tubes and means, and the axes of the tubes being parallel with each other and with the axis of the means, whereby the air and fuel in traversing the feeder are thoroughly mixed and are discharged in lines parallel with the axis of the means for forming the stream of the air and fuel mixture. Nine claims.

940,050. AUTOMATIC SHUT-OFF. JAMES F. PARKER, OF PITTSBURG, PA., ASSIGNOR TO PITTSBURG AUTOMATIC SMOKE PREVENTER COMPANY, OF PITTSBURG, PA., A COPARTNERSHIP.

Claim 2.—In an automatic shut-off, the combination of a pipe, a valve carried thereby and provided with an elongated stem, of a drum loosely mounted upon said stem and having two compartments formed therein, a counterpoise located in one of said compartments, a flanged collar carried by said drum, an actuating rod movably supported by said pipe and connected to said collar, a dash pot supported by said pipe and having a plunger connected to said collar, and means for simultaneously revolving said drum and said valve stem. Five claims.

THE BOILER MAKER

FEBRUARY, 1910

THE POWERING OF BOILER SHOPS.

BY D. S. DOWNS.

The economic powering of the boiler shop, like that of all other industrial shops, is a problem which has passed through the hands of the most experienced of engineers. The result of their recommendations and the added experience resulting therefrom have placed the electric powering problem at such a point that certain lines of equipment are known to be suitable for certain work, and can be depended upon for their efficiency and reliability.

The time has come, and it is felt by the consulting engineer who is in charge of the equipment of new plants, that a great deal of responsibility depends upon his choice of equipment and the layout which he recommends as most economical and efficient. Too often have shops and factories been built and equipped with no intimate bearing upon future operations. Unsuitable types of buildings and cheap or inadequate equipment of boiler shops have been the cause of a large number of concerns laboring under excessive investments and manufacturing conditions which detract from their chance of expansion and development. It is the object of the writer in this article to review a few of the most important points which determine the boiler shop equipment, and in a later article to discuss the working out of some particular equipment, showing the relative advantages of the various types of electric drives as applied to boiler shop tools.

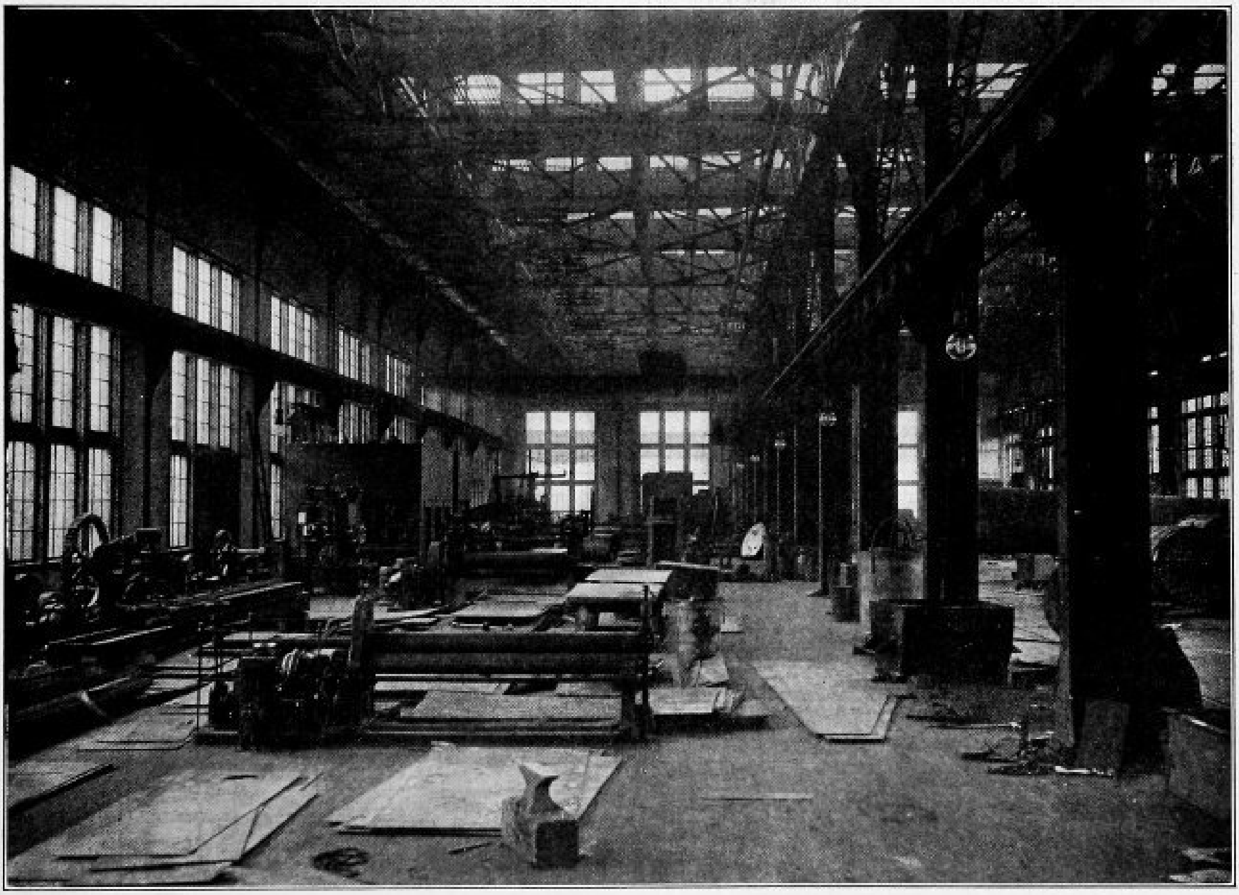


FIG. 1.—BOILER SHOP OF THE PITTSBURG & LAKE ERIE R. R., EQUIPPED WITH ELECTRIC DRIVE.

The factors which enter into the powering of any plant are based upon the economic production of the output, the nature of the products handled and the chance for future development.

The older plants which have installed steam power and complicated mechanical transmission by means of ropes and line shafts, have found them to a large extent unsatisfactory in fulfilling these conditions. Factory managers and superintendents have demonstrated to themselves by comparative tests on steam and electrically-driven plants that in the steam-driven plants only about 66 2/3 percent of the power generated is delivered to the machines actually doing the work; that is, one-third of all the power produced in the mechanically-driven equipment under full load is lost, or rather absorbed, during its transmission from the point of generation to the point of application. This loss is practically constant, regardless of the number of machines in operation. Actual tests have shown that the average load factor is about 50 percent in most steam power plants. In the electrically-equipped plants the efficiency varies slightly, according to the load, and is as high as 85 percent at half or three-quarters load. Electrical equipments have come to be considered standard, and the benefits are so well known that all installing engineers specify them.

The electrical equipment has been much talked of from the standpoint of decreased cost of operation and decreased cost of equipment. Arguments to this effect have been advanced by the sales departments of large companies. These arguments, although true in the main, do not show up the real merits and financial advantages of the electric drive. The actual result of an electrical equipment is a reduction of the unit cost. The investment may be larger and the operating cost may be larger, but more work is turned out in the same time, so that upon totaling up the unit cost is shown much reduced. This point is very well illustrated in case it is necessary to extend a shop and revise a mechanical system. The necessary expenditure for additional steam facilities and line shafts may be only one-third that of the amount necessary to provide electrical equipment. In this case an increased cost of equipment is evident. With the electrical equipment installed the operating cost does not go down; that is, the fuel consumed does not go down, but up, and the output goes up. The increased efficiency is distributed about the entire equipment, and the result is an output at a very much reduced cost, or a unit cost considerably reduced. The total saving on the investment, due to this reduced cost in every case, shows up as a favorable rate of interest on the investment.

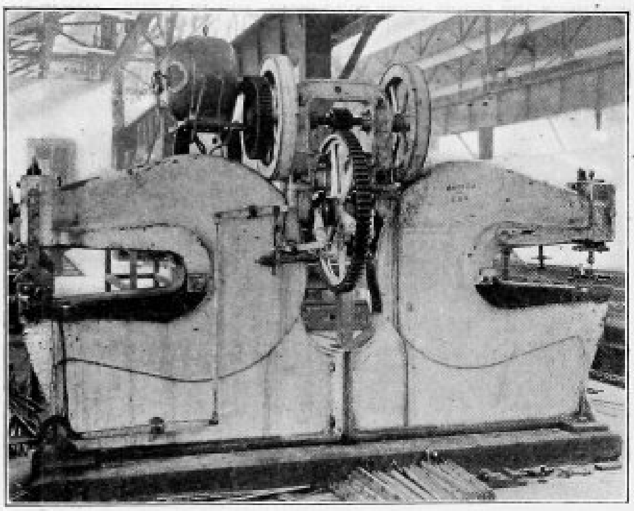


FIG. 2.—MOTOR-DRIVEN COMBINED PUNCH AND SHEAR.

The relation of the second factor of powering a plant, namely, the relation to the product handled, although secondary to production, is equally important from the standpoint of economy. In connection with the powering of tools to handle certain work, and the question of changing over old tools, more falls to the task of the superintendent than a mere matter of guesswork. Machine tools are designed to withstand certain strains and stresses in connection with shafts, bearings, etc., and it is as uneconomical to try to make a tool do less work than it is constructed for as it is uneconomical to make it do more work than it can safely stand. To guard against this condition of affairs manufacturers of tools to-day are providing the necessary instructions and attachments to convert the belt-driven tools from a belt drive to a motor drive. With the belt drive the machines are connected to their source of power in such a way that when they come to an overload point they refuse to take the power, causing the belts to slip and using up the excess power in friction. With the direct-connected motor drive the machine is not given this alternative, and it is here that the engineering precision required by the motor drive means its greatest source of power saving, by holding each machine at its most efficient load.

Knowing the safe working load for the machine tools, the motor size can be accurately computed for maintaining its economic working. For the motor, rotative power is the product of speed and torque, and work is the product to rotative power and time. Manufacturers of electrical machines now furnish upon request guaranteed performance curves for any motor, and will, from specifications submitted, solve individual problems and recommend sizes of motors for any use. These results are easily checked by the engineer from his specification curves and the operating conditions of his special tools. After the motor installation has been made, the machine then operating at a unit can be easily tested by reliable methods from time to time and the efficiency ascertained. A record can then be made of such a machine on an efficiency time chart. For a plant which has its layout arranged so that every machine unit has a certain work charged to it, such a work means much in determining the accurate factory cost and the condition of the manufacturing cost.

The problem of motor equipment for tools such as used in boiler shops, for instance, punches, shears, drills and bending rolls, is one which is being seriously considered by all machine builders. An efficient motor drive installed on an out-of-date tool has often resulted in a prejudiced opinion as to a certain machine's make; and it has, therefore, fallen to the machine-tool builder to assure his customers that the tool furnished has been designed as a unit, that the powering has received the same care in the design and construction as any other part of the machine. With recommendations of this nature the customer is protected against any error in instruction on the part of his engineering department.

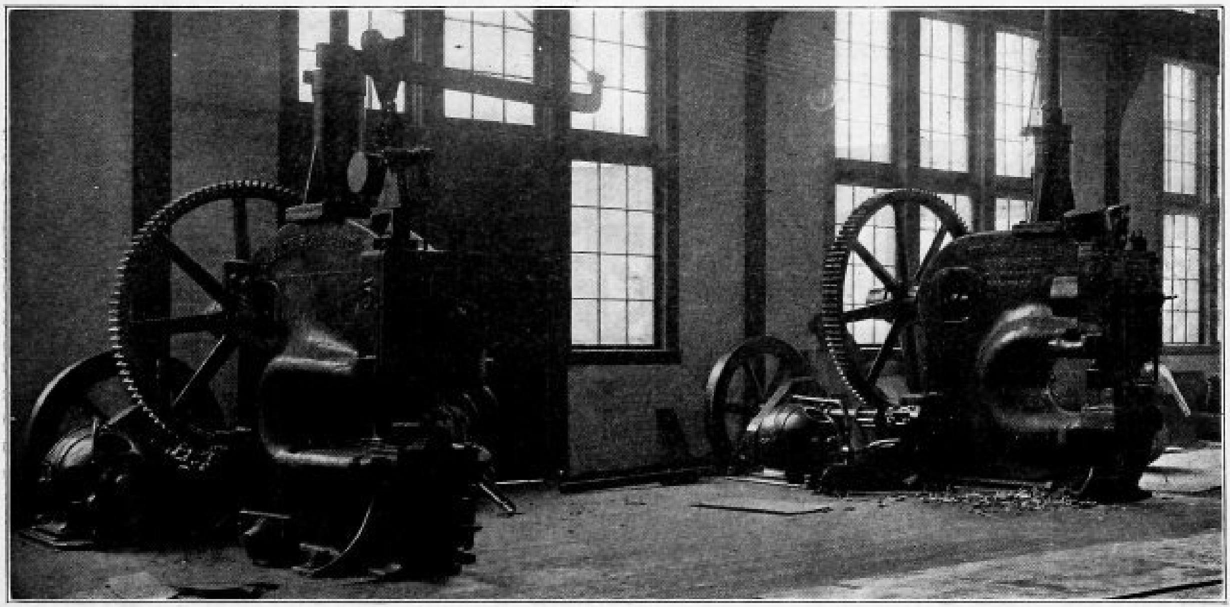
The third factor in the powering of the shop is one which is too often treated conservatively. It is a very simple thing to increase the power of an electrical equipment, provided the proper expansion factor has been considered in the original layout of the equipment. This factor, it is true, depends upon the present operating conditions and the most economical operating load that can be carried, and on account of this, therefore, units must be carefully selected.

The power house units and designs of the equipments should always be of such natures as to allow for considerable flexibility. A selection of three small units equivalent to two large ones may seem an extravagant expenditure at the time, still, after a few years of natural development, it is usually found more satisfactory for an even distribution of the load and for a sufficient emergency capacity.

In regard to the nature of the electrical system which is best adapted for the boiler shop, there is a considerable variety of opinion. In the main there are two distinct systems, with a third which is a combination of these two main systems, namely, the direct-current and alternating-current systems, and a combination of the direct current for main units with alternating currents for auxiliary, or with alternating currents as main units and direct current as an auxiliary system.

From a review of the recent installations in some of the larger boiler shops and large railway shops, it would seem that the alternating-current system, with provisions for converting to direct current, is the most economical and satisfactory. This inference, too, can be well substantiated by many considerations as to the power distribution for machines and the nature of the machines driven.

Certain machines requiring adjustable speed are most satisfactorily operated by direct-current motors, because of the fact that in order to get sufficient regulation with alternating-current motors complicated mechanical speed-changing devices are necessary. For constant-speed running, on the other hand, the induction motor is most satisfactory and much more economical. The wiring is much smaller on a large system, and the generators and motors are simple and reliable. With outlying plants and long-distance transmission the alternating-current system saves much waste of energy from switchboard to machines.



3.—TWO APPLICATIONS OF MOTOR-DRIVE IN A BOILER SHOP.

The relative advantages of the electrical equipment are many. The principal among these, however, is the reduction in the unit cost already mentioned. Aside from this there is a certain class of advantages which it is hard to classify or to attach a value to. Some of these are cleanliness, convenience of placing machines without reference to power supply, ease of motor control and automatic operation, elimination to a large degree of belts and loose pulleys, increased safety and freedom from accidents to employees, economy of floor space, more light and less noise. These advantages are given a value in terms of increased production, in which cases it is often set as high as 25 percent.

Some boiler trials were recently made to determine the effect of soot on boiler tubes. During the first series of tests the soot was allowed to remain on the tubes. The evaporation from and at 212 degrees per pound of dry fuel was 6.2 pounds. The dry coal per square foot of grate area was 13.14 pounds, and the temperature of the escaping gases 627 degrees F. Before the second series of tests was made, the tubes were carefully cleaned, with the result that the evaporation from and at 212 degrees per pound of dry fuel increased to 7.04 pounds, a gain of 13½ percent.

NOTES ON MARINE BOILER DESIGN, CONSTRUCTION AND ECONOMY.*

BY D. MYLES.

In preparing this paper the writer's aim is to draw the attention of the members to some modifications and improvements in the design and manufacture of boilers and economy in the consumption of coal, due to the increased pressure from about 80 pounds per square inch to 180 pounds, or 220 pounds per square inch; and as there are sure to be considerable differences of opinion and practice in these matters, he trusts there will be a good discussion, and hopes that by the exchange of ideas some useful lessons may be learned.

Among the important changes that have taken place in recent years have been the substitution of steel for iron in the manufacture of marine boilers, and the more recent adoption of steel with a high tensile strength. This latter advance has been rendered possible by the improvements introduced by the steel makers, and while complimenting them on the success they have already achieved, the fact that occasional defects are found in steel plates made by the most eminent firms of steel manufacturers in the world, leaves them room for further advance in the way of providing material which will be absolutely reliable in every respect, and which will merit the confidence of engineers. The shipowners' attention is necessarily largely given to the commercial side of running the steamers and naturally they do not wish to have to devote time to highly technical questions, such as the cause of laminations, cracks or other defects which sometimes develop in steel boiler plates.

The experience of a number of years seems to indicate that, with proper care and attention, the life of a steel boiler at the higher pressure will be quite as long as that of boilers working at the lower pressures usual when iron was the material principally used in their manufacture, but to obtain this result, boilers still require thorough cleaning and attention, and I regret that the exigencies of trade and competition compel owners to shorten time in harbor, and consequently the boilers are not so thoroughly cleaned as otherwise they would be.

* Read before the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne, England, October, 1909.

DESIGNS.

Considering the improvements in boiler design during recent years, as a result of wider experience, what strikes the writer most is the great change of opinion and practice with regard to crowding a large amount of heating surface into the smallest possible boiler, thereby reducing the space for cleaning and examination and otherwise making the boiler unsatisfactory. Boilers which a few years ago were considered large enough to contain about 2,400 square feet of heating surface are now usually made 9 inches or 12 inches larger in diameter. This extra size is due to a number of causes, the principal of which are the larger spaces between combustion chambers, between nests of tubes, and between steam space stays, thereby making the boiler much more accessible for cleaning, and as ships' engineers, together with boiler cleaners, are very human, the boiler that is not easily accessible is very liable to go improperly cleaned, and the opposite, of course, also holds good that a boiler easily accessible is much more likely to be thoroughly cleaned, and in boiler treatment cleanliness is of the very highest importance if long life and satisfactory results are to be obtained.

Another change which has gradually taken place is the increased importance which is attached to large combustion chambers. This is a change which very materially tends towards increased efficiency and economy in the working of the boilers, and it is a movement in the right direction, although, like everything else, it is possible to overdo it. This alteration is a great improvement in boilers intended to work under natural or forced draft, and has been found to be of the utmost importance in boilers intended for burning liquid fuel.

Improvements in steel works and in boiler shop plants have enabled boilermakers to use thicker plates than was customary in recent years, thus obviating the necessity of riveting on covering plates, which at one time were frequently fitted to the boiler ends and spaces between nests of tubes, thus providing the shipowner with a more satisfactory boiler, as every additional rivet hole is a possible source of trouble during the life of the boilers.

The same improvement in steel works has enabled steel makers to provide boilermakers with larger plates, thus reducing the number of seams, and it is now pretty nearly a common practice for single-ended boilers, even of large dimensions, to be made in one strake of shell plates, the benefits of which are so obvious that the writer does not think it necessary to mention them.

The increase of pressure referred to in the beginning of the paper has also led to a development in manhole doors, and the flanged doors (now so frequently placed in the ends of boilers), together with the grooved manhole door, are very great improvements on the doors that were generally used in the days of lower pressures.

The use of corrugated furnaces has become more common in recent years. The advantages of these furnaces are somewhat outside the scope of this paper and have been amply insisted upon by the patentees of the various sections, but although they have proved quite satisfactory they have only a certain commercial value, and it is quite possible we may shortly renew our acquaintance with our old friend the plain furnace. The Gourlay-Stephen back end, introduced by the late Mr. Kemp, of Govan, or the Ashlin type, introduced by the late Mr. Ashlin, of Liverpool, possess advantages facilitating renewal so obvious that they have practically become universal, and the older type of furnaces flanged at the back end to take the back-tube plate are now practically obsolete, as also is the practice, sometimes previously adopted, of welding the furnace to the back-tube plate.

The great increase in the number of Classification Societies, due to Continental countries having in so many cases adopted rules of their own, as well as to the formation of new societies at home, has made the work of the boiler designer rather more difficult than it appears to the writer to be altogether desirable, and while the labors of the recent Standardization Committee have done a considerable amount of good in the direction of removing the differences between the various societies' rules, there is still room for further improvement in the direction of uniform tests. Materials being the same and the work required also the same, the writer fails to see why similar tests cannot be agreed upon, and while the writer values the labors of the members of the different Classification Societies, it appears to him doubtful if an adequate return is obtained for the extra expense incurred in connection with these different surveys. This expense inevitably falls on the shipowner.

MANUFACTURE.

With regard to the manufacture of marine boilers, the higher pressure has effectually put an end to the time when, as sometimes happened, a boiler was prepared for the official test by the introduction of a little sal ammoniac in the neighborhood of the seams of the plates, and boilers that can satisfactorily stand the working pressures general to-day have to be honestly fitted metal to metal, and the workmanship has to be beyond doubt. This severe demand on accuracy and workmanship will be admitted by those of you who remember that not so many years ago it was no unusual thing for shipyard platers, riveters and calkers to be employed in the boiler shop. This, in the writer's experience, has now entirely ceased, and boilermakers are properly trained for the important work they have to do, and hand-calking is now largely replaced by pneumatic calking.

Along with the improvement in workmanship, there have been vast improvements made in machines used in the manufacture of boilers. The holes for stay tubes, which a few years ago were tapped by hand, are now almost universally accurately tapped by machine, and this applies also to stay holes between combustion chambers, boiler backs, etc., and a hole tapped by machine is more likely to be true and fair than one tapped by a man pulling at the end of a long single-ended lever, as was frequently the case in former years, and if the hole is truer the screwed stay will necessarily be a better fit.

The same remark applies to the greatly increased use of electric or pneumatic drills instead of the hand ratchet brace, and although this improvement may be also in the direction of economy in costs, the more accurate workmanship is undoubtedly in the direction of improvement in the manufacture of boilers.

The practice adopted by some builders of boring out the flanged opening in the boiler front plate for the front end of the furnace, appears to the writer to be a somewhat doubtful advantage. If the furnace is a good fit in the flange, a matter which does not present any great difficulty, I think there is nothing to be gained by machining the surface, but the removal of scale due to flanging and heating is necessary in all joints.

The larger boiler plates already mentioned have necessitated larger and more improved machinery in the boiler shop to handle them during the manufacture of the boiler, and also entail more careful and responsible work on the part of the workmen, with the result that boiler manufacturers are able to supply their clients with boilers which with ordinary careful treatment give less trouble than was the case when the pressures did not exceed half what they are at present.

The size of boilers which can be built nowadays is only limited by the economy in working. Double-ended boilers, working at 190 pounds pressure per square inch, and weighing over 100 tons per boiler, have frequently been fitted with very satisfactory results; in fact, some of these boilers are the most efficient that the writer has had any experience of.

The Classification Societies' rule that boilers must be tested to twice the working pressure is a relic of bygone days and ought to be deleted from the societies' rules. I do not see any objection to continuing to make the boilers capable to stand this pressure, but I consider the extra calking necessary to prepare the boiler for this test is really detrimental to the boiler, and without any equivalent compensating benefit.

A recent improvement in combustion chamber side plates is worthy of careful consideration by all interested in marine boilers. By this improvement the wrapper plate is made all in one piece, but of different thicknesses to suit the requirements of the designer, and so saves the three-ply joints where the thick bottom plate joins the thin side plate, and which joints so frequently give trouble in actual working of the boilers.

With regard to future development, the writer does not like to attempt the rôle of a prophet, but it appears to him that while water-tube boilers are absolutely essential for certain classes of work, they, like everything else, have their limitations, and while they have overcome troubles arising from quick raising of steam, forced evaporation, etc., they bring with them defects and troubles to which the ordinary type of marine boiler is not subject, and which will restrict them to vessels for special service, and the ordinary return tube type of marine boiler has still a long and useful career before it.

The writer has always considered calking as rather a barbarous method of making seams of boilers tight, but it is very difficult to propose a satisfactory substitute. The electric arc, oxy-acetylene, or any other method of welding has disadvantages, which at present appear fatal, but from the advances that have already been made in this direction the writer hopes that some further improvement will be made in the near future, and that a more satisfactory method of making boiler seams tight, without interfering with the movement due to expansion, will yet be discovered.

Apparatus for burning liquid fuel in marine boilers has made very great advances in recent years, and there are systems now at the disposal of engineers which, if proper care be exercised in designing and working the boilers, can be used with perfect safety as regards the life of the boiler. Liquid fuel, however, is not an unmixed blessing, and if an undue proportion of water be mixed with it, a natural and not unusual defect, the result will of necessity be unsatisfactory, and may even be disastrous. To get satisfactory results with liquid fuel the boilers should be specially designed for this purpose and it should not be attempted to build a boiler, or arrange furnace and burners to use liquid fuel or coal alternately, as satisfactory and economical results cannot be got by this attempted combination. The adoption of oil fuel will to a large extent be limited by the available supply, and I do not think that owners of collieries need have any great fear of serious competition from this source.

Mechanical stokers for marine purposes do not appear to have made any great advance. Several systems have been tried with fluctuating success, but I think it will be a long time before the properly trained fireman will be superseded.

Excepting in Canadian lake steamers, I have not heard of any attempt to arrange for self-trimming in the bunkers during the voyage, and I think this is a matter worthy of attention.

The increased technical knowledge and better training of most of our sea-going engineers has fitted them to take a more intelligent and rational interest in their boilers than was always the case in past years, and the improvement that has been made in this direction will undoubtedly continue. When one considers the history, a not uncommon case, of two steamers built at the same time, fitted with boilers by the same makers, and apparently subjected to the same treatment, one set of which has a comparatively short life—say five or six years—while the other lasts two or three times as long, there cannot be much doubt that the longevity of boilers is principally due to the care taken by the superintendents and sea-going engineers in whose charge they are placed. At the same time, the necessity of immediately attending to any leaks that may develop cannot be too strongly impressed on sea-going engineers, as grooving very quickly starts and may soon grow to serious proportions. The responsibility of the sea-going engineer, and the advisability of dealing with his certificate in case of carelessness or neglect of duty as is done with ship-masters, is a question worthy of consideration.

In this respect, also, the improved appliances and better accommodation now provided for firemen play an important part, and the recent move by the Board of Trade in directing attention to the ventilation of stokeholds is a very important one, provided it be carried out in such a way as not to unduly harass the shipowners and their representatives, who should certainly not be left at the mercy of the individual ideas of the surveyors at various ports. Defective ventilation in the stokehold has not infrequently been the real cause of unsatisfactory speed of the vessel, which, in the first place, was perhaps naturally attributed to a faulty propeller. This defect may also have a very important influence on economy of consumption and is sometimes the real cause of serious and justifiable complaint from the shipowner.

BOILER EXPLOSIONS AND RIVETED JOINTS.*

BY JAMES CROMBIE.

At the convention of the International Master Boiler Makers' Association held recently in Louisville, Ky., the fact was brought out that in the United States and adjacent parts of Canada the average number of boiler explosions was about 300 per year for the past twenty years. In Germany, where nearly the same number of boilers are in use, they have an average of seven explosions per year. In that country they have laws that cover every boiler that is used; no matter for what purpose or where situated, it must be inspected. From the pages of *The Locomotive* for the past forty-one years there have been in the United States and adjacent parts of Canada no less than 10,051 explosions, resulting in the death of 10,882 persons, or a total of dead and injured of 26,518, and this does not include the present year.

The year which is just closing has the largest loss of property, through explosions, of any year that we know of. In October three watertube boilers in Milwaukee, Wis., exploded, causing a property loss of over $100,000, and loss of business of $300,000. When you consider the foregoing statements you will readily acknowledge that it is up to the examiner to look out for signs of decay in the boiler, to examine the interior surfaces for cracks, pitting or grooving. All braces should be carefully examined, and any defects reported at once.

One very frequent cause of failure in boilers is the lap joint. This form of joint is being rapidly displaced and butt joints with cover plates, both inside and outside, are now used.

The lap joint has still a large field of usefulness in the smaller class of boilers, and in small locomotive-type boilers for use in sawmill and mining and road and field work. In these boilers the lap joint is extensively used and will make nearly as good a joint as some of the butt joints with a narrow strap outside and wide strap inside. This form of butt joint has the same bending action on the shell plate as the lap joint, though not to the same extent, but there is this fact to be noted, that the lap joint will be treated with suspicion and

* Abstract of an address delivered before the Hamilton branch of the C. A. S. E.

carefully looked after, and this butt joint will be trusted because it shows a much higher efficiency, an efficiency that it does not deserve, and it will not be looked after so carefully. If cracks should develop they are hidden from the outside of the boiler by the brickwork casing, and cannot be seen from the inside, owing to the wide strap, the fracture usually occurring along the outer row of rivets in the shell plate. The best form of joint is the butt joint, with outside and inside cover plates of the same width, having double, triple or quadruple riveting according to the size of boiler and the working pressure required.

To find the working pressure for the shell of the boiler, the formula usually employed is,

$$W\,P = \frac{T\,S \times t \times E}{R \times F}$$

Where $W\,P$ = Maximum working pressure per square inch,
$T\,S$ = Tensile strength of plate in pounds per square inch,
t = Thickness of plate in inches,
E = Efficiency of joint,
R = Radius of boiler,
F = Factor of safety.

Let us assume a small locomotive-type boiler with a double-lap joint, with plate 5/16 inch thick; that is, $t = .3125$, $T\,S$ = 60,000 pounds, R = 15 inches, F = 5.5, then

$$WP = \frac{60{,}000 \times .3125 \times E}{15 \times 5.5}$$

We must now find the value of E. There is a limiting formula which will give us the maximum pitch of rivets in our joint.

$$\text{Pitch} = (C \times F) + 1\tfrac{5}{8}.$$

Where C is a constant = 2.62 for two rivets in lap joint.
3.47 for three rivets in lap joint.

As we are using a double-lap joint we will have two rivets, and the constant will be 2.62, then pitch = $(2.62 \times .3125) + 1\frac{5}{8} = 2.44$ inches. Then to find the efficiency of this joint of 2.44 pitch, and using 11/16 rivets in ¾-inch holes, we have for plate between the rivet holes $K_t = \frac{P - D}{P}$, where P = pitch, D = diameter rivet hole.

$$K_t = \frac{2.44 - .75}{2.44} = 67 \text{ percent efficiency.}$$

We have also to find out the value of the rivet section, and we have for shearing on the rivets

$$K_s = \frac{n \times s \times a}{P \times F \times T\,S} = \text{percent,}$$

where n = number of rivets, s = shearing strength of steel rivets in single shear = 42,000 pounds, and a = area of rivet hole = .4418. P = pitch, t = thickness of plate = 5/16, $T\,S$ tensile strength of plate = 60,000 pounds.

$$K_s = \frac{2 \times 42{,}000 \times .4418}{2.44 \times .3125 \times 60{,}000} = 79 \text{ percent.}$$

Plate section then = 67 percent and rivet section = 79 percent. The lowest value is 67 percent, and this is the value required to complete our formula

$$WP = \frac{.3125 \times 60{,}000 \times .67}{.15 \times 5.5} = 152 \text{ pounds working pressure.}$$

We have used 5.5 as a factor of safety, but many of the insurance companies use 5, and this would give us a still greater pressure, namely, 167 pounds. Suppose we use a triple-lap joint, then pitch = $(3.47 \times .3125) + 1\frac{5}{8} = 2.709$ inches.

$$K_t = \frac{2.7 - .75}{2.7} = 72 \text{ percent;}$$

substituting this value for E, and with a factor of safety of 5, we would get a working pressure on this boiler of 180 pounds per square inch.

We will now take a tubular boiler of 60 inches diameter, ⅜-inch plate, and use double and triple-riveted butt joints, and find the allowable working pressure, where $T\,S$ = 55,000, s shearing strength of steel rivets 42,000 pounds, S shearing strength of steel in double shear, 1.80 of single shear, some authorities only allow 1.75 instead of 1.80.

T = ⅜ inch = .375 inch.
D = Diameter of rivet hole 13/16 = .8125 inch.
A = Area of rivet hole .5185 square inch, with double-riveted butt joint at 3½-inch pitch.

$$K_t = \frac{3.5 \times .8125}{3.5} = 76 \text{ percent.}$$

$$K_s = \frac{.5185 \times 42{,}000 \times 2 \times 1.80}{3.5 \times .375 \times 55{,}000} = 1.08 \text{ percent.}$$

The lowest value is 76 percent, then

$$W\,P = \frac{55{,}000 \times .375 \times .76}{30 \times 5.5} = 95 \text{ pounds.}$$

Using plate 60,000 pounds

$$W\,P = \frac{60{,}000 \times .375 \times .76}{30 \times 5.5} =$$

103.6 pounds working pressure.

Using a triple-riveted butt joint, pitch 6½ inches,

$$K_t = \frac{6.5 - .8125}{6.5} = .875 \text{ percent.}$$

For K_s we have the shearing strength of four rivets in double shear, plus the shearing strength of one rivet in single shear.

$$K_s = \frac{N\,S\,a + n\,s\,a}{P \times t \times T\,S} = \frac{4 \times 75{,}000 \times .5785 + (1 \times 42{,}000 \times .5185)}{6.5 \times .375 \times 60{,}000} = 121 \text{ percent.}$$

For K_{st} = strength of plate between rivet holes on second row plus shearing strength of one rivet in single shear in the outer row.

$$K_{st} = \frac{6.5 - (2 \times .8125) \times .375 \times 60{,}000 + (1 \times 42{,}000 \times .5185)}{6.5 \times .375 \times 60{,}000} = 89 \text{ percent.}$$

The lowest value is 87 percent, then

$$W\,P = \frac{60{,}000 \times .375 \times .87}{30 \times 5.5} = 112 \text{ pounds working pressure,}$$

using ½-inch plate, then

$$\frac{60{,}000 \times .5 \times .87}{30 \times 5.5} = 185 \text{ pounds working pressure.}$$

This is for a butt with two rows of rivets on outer strap and three rows on inner strap; the chief reason for employing this strap is for the calking, the rivets are pitched close along the outside edge, and the plate will not spring as it would if the outer strap had the wide pitch.

We will turn for a few minutes to the end of our boiler, the formula for finding the area to be stayed above the tubes is

$$\frac{4\,H^2}{3}\sqrt{\frac{2 \times R}{H} - .608} = \text{area.}$$

H = Height above tubes minus 5 inches.
R = Radius of boiler minus 3 inches.

The area so formed is then the surface to be stayed, and is treated as a flat surface.

There are several rules for staying flat surfaces.

$$W\,P = \frac{C \times T^2}{P^2}$$

Where T = thickness of plate in sixteenths of an inch.
P = maximum pitch of stays in inches.
C = 112 for plates 7/16 inch or under.
C = 120 for plates over 7/16 inch.

Another rule is

$$\frac{C \times (T + 1)^2}{S - 6} = W\,P.$$

T = thickness of plates in sixteenths of an inch.
S = surfaces supported in square inches.
C = a constant, varying from 36 to 150, according to different methods of staying.

In closing I would refer for a short time to the constant for finding the maximum pitch of rivets as we found in our lap joint.

You will remember that the pitch we found was 2.44 inches. Now the strange thing is that the smaller the rivet the higher percentage of plate we have, using in each case 5/16 plate and different size rivets, as

$$K_t = \frac{P - D}{P} = \frac{2.44 - 11/16}{2.44} = .718 \text{ percent.}$$

$$K_t = \frac{2.44 - 3/4}{2.44} = 69 \text{ percent.}$$

$$K_t = \frac{2.44 - 13/16}{2.44} = 62 \text{ percent.}$$

And on using a 13/16 rivet we only get 62 percent, because we have taken 1/8 inch more metal from between our rivet holes. It is a pity that we could not have a maximum pitch for a certain size of rivet and plate thickness, and then on adding a larger size of rivet to add this amount to the pitch; as, for instance, we have 2.44 for 11/16 rivets, and the difference between 13/16 inch and 11/16 inch is 1/8 inch, adding this to our pitch 2.44 + .125 = 2.565, our new pitch, then our joint would be

$$K_t = \frac{2.56 - .8125}{2.56} = 68 \text{ percent, and}$$

$$K_s = \frac{2 \times .5185 \times 42{,}000}{2.56 \times .3125 \times 60{,}000} = .907 \text{ percent off of rivet section.}$$

We have now an efficiency for our joint of 68 percent and 90 percent; but we cannot make this change, but must abide by this present formula until we can get it changed.

There are other formulas in dealing with riveted joints, as, for instance, the diagonal pitch of our rivets may equal 3/10 $P + d$ in outer row, or $\frac{3P + 4d}{10}$ for diagonal pitch at inner row. And the distance between the lines is found by this formula $\sqrt{(11/20\,P + d)\;1/20\,P + d} = V$ at outer row, and

$$\frac{\sqrt{(11\,P + 8\,d)\;(P + 8\,d)}}{20} = V_1$$

the distance between inner and middle row of rivets.

NOTES ON BOILER DESIGN—RECENT VIEWS OF ENGLISH EXPERTS.

BY CHARLES TRAVIS.

During the year 1909 English experts and engineers interested in the designing and practical working of boilers have been keenly discussing the merits of proposals for the modifications in boiler design which have been made. One school upholds the view that important advantages may result from the suggested improvements, while the other questions the possibility of boilers of the present type being capable of any further important modifications. The opinions pro and con are summarized in this article for the information of readers of THE BOILER MAKER, and they may be useful for future reference.

A question which has been under discussion in England is the effect on boiler plates of the water in use in districts where it contains various matters in solution, which tend to corrode the plates and to shorten the lives of boilers; it is obviously in the interest of a boiler maker to ascertain the characteristics of the water with which his boiler will be fed, and to advise his customer how to remedy any injurious effect it may have, so that the boiler may last out its allotted career. Should the water used shorten the life of the boiler, the buyer is more likely to blame the boiler maker than the water he uses. In many districts the water available has a corrosive action on steam boilers, those, for instance, known as "magnesian" in some limestone districts. A noted specialist has devised a method by which the corrosive properties of any water can be ascertained in the laboratory under conditions such as prevail within the boiler, so that the boiler maker could make his own tests before delivering his boiler and advise the buyer accordingly.

A measured quantity of water is heated with a weighed and measured quantity of steel wire at such a pressure as would be used in the steam boiler and the loss in weight which the wire suffers after a given time is ascertained. Experiments have been carried out at a pressure of 100 pounds to the square inch, which could be repeated with a higher one—up to, say, 300 pounds—or a smaller one.

The process is one by which it can be ascertained how different qualities of steel or iron are affected; in other words, which will offer the greatest resistance to a given water supply. The degree of corrosiveness at different concentrations can also be determined by the boiler maker, who will be able to advise his customer, or to regulate his construction, design or material accordingly. It is known that the magnesian waters, which contain a sufficient quantity of carbonate of lime, do not act corrosively on steel or iron plates, this has been again experimentally confirmed; as most magnesian waters contain both magnesia and lime compounds, the bad reputation which they have obtained is undeserved, and is due to the fact that being excessively hard, they produce a large amount of scale, which with careless management will act injuriously on the boiler plates; but it appears that a magnesian water may, after softening, be more corrosive than it was in its natural state, if the softening operation is not carried out properly. Boiler makers should note that in magnesian waters particularly, the softening process is a scientific operation, which requires efficient management and supervision, *and they should advise their customers accordingly, to protect their boilers and prolong their life, as well as their own good name.* It is a curious fact that, although sea water contains magnesian salts, its corrosive action on iron and steel is not reduced by the addition of carbonate of lime. Experts have ascertained that the addition of calcium hydrate (slacked lime) completely stops corrosive action. By using suitable apparatus in multiple effect, sea water could thus be distilled without fear of corrosion in iron or steel vessels.

A noted English boiler expert has embodied his ideas on boiler construction in a proposed new type in an effort to obtain in practice, the maximum possible theoretical effect, and to reduce loss to a minimum; the ideas have been embodied in a patent, which is notable, as it embodies ideas on boiler design, with special attention to high internal gas speeds and forced water circulation. The main part of the boiler is similar to the ordinary Lancashire or Cornish boiler, except as regards the internal flue. The grate is placed as usual and is followed by a length of firebrick-lined flue, in which the combustion is to be completed. It may be noted that the furnace proper is not brick lined, so that as much radiant heat as possible may be transmitted through the furnace plates to the water. Following the combustion chamber, the last length of the internal flue is all but filled by a firebrick plug, through the narrow space between which and the boiler flue plates the gases are drawn by a fan at high velocity. After leaving the internal flue, the gases pass through first an evaporator and then an economizer. These last two are similar in construction and are arranged for high-speed counter current gas and water flows, the gases being finally discharged to the chimney by a fan. A pump forces the feed water through the economizer and the evaporator, and in passing through the evaporator it is joined by water taken from the main boiler and circulated by way of the evaporator back into the boiler again. It is specified by the inventor that the ratio of surface to cross-sectional area of the high-speed portions of the boiler must not be less than 750 to 1; in this way it is expected to reduce the final temperature of the gases to a very low figure and thus to increase the efficiency of the boiler.

An interesting improvement in boiler construction has been at work for some years in large works near Manchester, England, details of which may interest readers, so far as they can be made clear without a sketch. It has already been demonstrated to the satisfaction of engineers that by inserting tubes into the flues of Lancashire boilers the increased heating surface thereby presented insures a more rapid generation of steam than is possible when no such tubes are used, and details of such an improvement were published in THE BOILER MAKER about two years ago. The improvement described below is on different lines. Among the principal points to be carefully considered in applying such tubes are their formation and the position they should occupy in the flue. In an ordinary Lancashire boiler the internal furnaces and flues are made up of twelve segments, the last but one of which tapers; the tubes are placed in five segments adjoining the taper; they are of drawn steel and 2 inches in diameter and are bent in the form of the letter N laid flat, with rounded bends to insure the free circulation of the water. In each segment of the furnace flue there are five of these N-shaped tubes, making twenty-five in all, or fifty for a boiler of the Lancashire type; that enables the water to circulate within the flue and does not, it is asserted, interfere with the draft. Each end of each tube penetrates the shell of the flue, and is secured thereto by expanding ends, not by riveting. Thus fixed a clear course is afforded for the circulation of the water between the lower and the upper part of the boiler chamber. The tubes are made to alternate at the points of communication with the boiler. For the purpose of inspection, increased space is given in the bending of the lower part of each tube, and as space is left between each set of tubes, ample accommodation is provided for examining the joints. From the tests given below it will be seen that a remarkable saving in coal is effected by using these tubes, these results call for careful consideration by steam users of the advantages to be derived from the use of such tubes in Lancashire boilers.

Tests of a Lancashire boiler before and after being fitted with circulation water tubes:

The boiler was of the ordinary Lancashire type, 7 feet in diameter and 28 feet long, and was set in a battery with two others of the same type, all alike, with the exception of the circulation tubes. The other two boilers of the battery are badly troubled with scale, which has to be chipped out every month; but owing to the rapid circulation of the water, *no scale* whatever forms in the boiler in which the tubes were inserted; the impurities are blown out as mud, the three boilers being fed by the same water.

The first set of tests were made previous to installing the circulating tubes; while the second tests were made after the circulation tubes were put in, but with no other alteration. The coal for both tests was obtained from the same colliery of the same quality and cost. The saving effected by the circulation tubes will be appreciated from the details given below:

FIRST TESTS.

COAL USED CWTS.	Ashes.	Per Cent of Ashes.	Gallons of Water.	Temperature of Feed Water.	Duration of Test.	Lb. of Water per Lb. of Coal.	Gallons per Ton of Coal.
1st day 32	3-2-0	10.9	2.405	61.7	6 hrs.	6.71	1,503
2nd day 35	3-1-5	9.6	2.960	61.7	6½ hrs.	7.55	1,691
3rd day 35	3-1-0	8.5	2.960	61.7	6½ hrs.	7.55	1,691

SECOND TESTS WITH TUBES.

COAL USED CWTS.	Ashes.	Per Cent of Ashes.	Gallons of Water.	Temperature of Feed Water.	Duration of Test.	Lb. of Water per Lb. of Coal.	Gallons per Ton of Coal.
1st day 32	2-0-10	6.7	3.145	61	6½ hrs.	8.77	1,965
2nd day 40	1-2-2	3.7	3.885	61	7¼ hrs.	8.67	1,942
3rd day 40	2-2-0	6.2	4.440	61	7¾ hrs.	9.91	2,220

Work at the Budapest Locomotive Works.

Special Agent Capt. Godfrey L. Carden writes in the *Daily Consular and Trade Reports:*

The Budapest Locomotive Works are turning out several types of locomotives more nearly approaching American standards than will probably be found in any other European shops. It may be said, further, that the Prairie and Atlantic types of locomotives, which the Hungarian State Railway shops are now turning out in Budapest, are unexcelled on the Continent. These Prairie and Atlantic types are complete American locomotives. Imagine one of the most modern of the big prairie class of locomotives of the Chicago-Denver lines, equipped with copper fire-boxes and copper stay-bolted throughout, with a valve gear of the highest efficiency, with a machining on all engine parts fit for exposition display, and one has a picture of the new Hungarian locomotive.

A NEW TYPE OF SCOTCH BOILER.

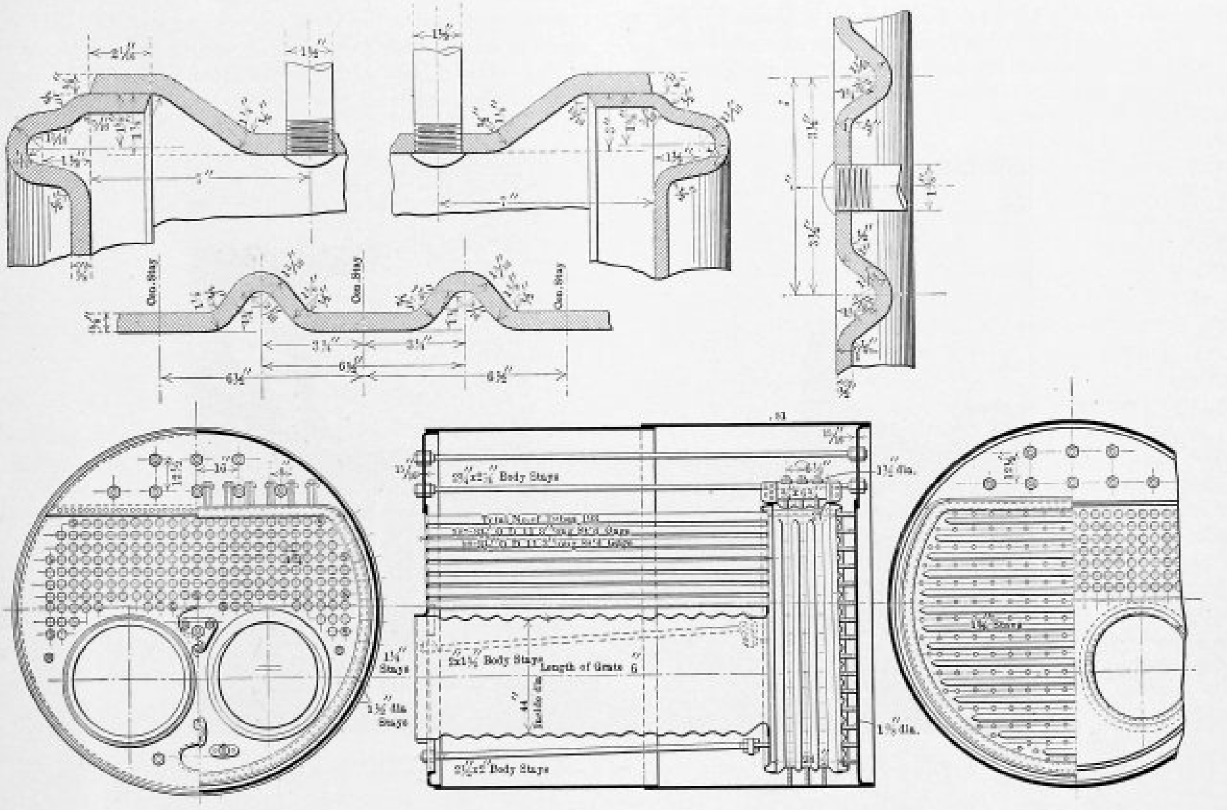
Complete descriptions of the corrugated fire-boxes manufactured by the William H. Wood Locomotive Firebox & Tube Plate Company, Media, Pa., have been published in previous issues. These fire-boxes have been used with success in locomotive boilers, and their success has led to the extension of the principle by the inventor to the building of a corrugated combustion chamber for a Scotch boiler. The general design can be seen at a glance from the illustration, and the manufacturer claims that the heating surface on the back plate is materially increased by the corrugations, and the strains due to unequal expansion and contraction entirely neutralized, thus preventing stay-bolt breakage. The tube plate is likewise corrugated around the outer edge, in order to increase the steaming qualifications of the boiler and prevent tube plate leakage.

The boiler illustrated is 14 feet 6 inches long and 11 feet 6 inches diameter, with two Morison corrugated furnaces 44 inches inside diameter and 7/16 inch thick. The furnaces lead to a common combustion chamber, and the hot gases are brought back through 193 tubes, of which 187 are plain tubes, 3½ inches outside diameter and 11 feet 3 inches long, and twelve are stay tubes 3½ inches outside diameter. Due to the corrugated construction; the stay tubes are not spaced as is customary in a Scotch boiler, but are simply distributed along the side and bottom rows of tubes.

The total heating surface of the boiler is 2,360 square feet, of which 1,975 square feet is in the tubes, 200 square feet in the combustion chamber, and 185 square feet in the furnaces. The grate area is 44 square feet, making the ratio of heating surface to grate area 53 to 1. The area through the tubes is 11.18 square feet, giving a ratio of grate area to tube area of 3.94 to 1.

The boiler is designed for a working pressure of 140 pounds per square inch, the shell plates being .81 inch thick, built in two courses. Both the front and back tube plates are ⅝ inch thick, the rear head of the combustion chamber being ½ inch thick, and the rear head of the boiler ⅝ inch thick. The portion of the front and rear heads above the tubes is 15/16 inch thick, and is stayed by eight body stays, 2¼ inches diameter, spaced 16 inches horizontally and 12½ inches vertically.

The chief novelty in the construction of the boiler is, of course, the combustion chamber, which is built entirely of corrugated plates. In the back plate these corrugations are 1¼ inches deep, spaced 7 inches between centers. Between the corrugations the plate is left flat, in order to receive the 1⅜-inch diameter stay-bolts which fasten the plate to the rear head of the boiler. These stay-bolts are spaced 7 inches, both horizontally and vertically. The horizontal corrugations do not extend clear to the flange of the plate, but there is a corrugation extending entirely around the edge of the plate at the flange.



SCOTCH BOILER WITH WOOD CORRUGATED COMBUSTION CHAMBER.

The wrapper sheet of the combustion chamber is formed in the same manner as the back tube sheet, except that the corrugations are spaced 6½ inches between centers and the flat portion is threaded for stays 1½ inches diameter, which in turn are supported by girders built of plate 6¾ inches wide by ¾ inch thick. The edges of the sheet forming the top of the combustion chamber are flanged upward, so that they form a flat support for the girders. This undoubtedly gives a better opportunity to support the girders than is ordinarily the case where they rest directly upon the flange of the tube and back sheets.

This construction of a corrugated combustion chamber evidently increases the heating surface slightly, and gives greater flexibility to the box, but there may be some question as to whether this flexibility is needed or not. Stay-bolt breakage is not very common in Scotch boilers, and neither does much cracking occur in the plates, due to excessive strains from unequal expansion and contraction. These defects are very common in locomotive boilers, and we understand that this type of construction has been successful in overcoming these faults in such boilers. Its application to Scotch boilers is, so far as we know, an untried experiment, and actual results will be awaited with interest.

FINISHING LONG STAY-BOLTS.

The method of finishing long stay-bolts in the Trenton shops of the Pennsylvania Railroad at Trenton, N. J., was described as follows in a recent issue of *The American Machinist:*

In Fig. 1 is shown a Pratt & Whitney open-turret lathe being used for this purpose.

Stay-bolts of this kind are forged with a square projecting from the head end, both for screwing them into place and for driving while being cut. Special box tools are made for turning these on the ends before threading, and there is also the special steady rest used to guide them as near the end as possible. The front cutters of the box tool turns the outside of the threaded portion, while the last cutter faces and chamfers the end ready for the die.

After this is done the circular-formed tool shown at the front of the cross-slide comes into play and turns the bolts to the correct diameter under the head, and at the same time gives the head its round form and undercuts the square end next the head, so as to be easily broken off after the stay-bolt has been screwed into place.

Fig. 2 shows the stay-bolts in the rough and after being finished, as well as the form of box tools used. By referring to this drawing it will be seen that the box tool has two cutting tools, one at the front for turning and the other at the rear for facing, both having directly opposite and above their cutting edges a pair of back-rest jaws, located at 90 degrees to each other, the front jaws being of rectangular form, while

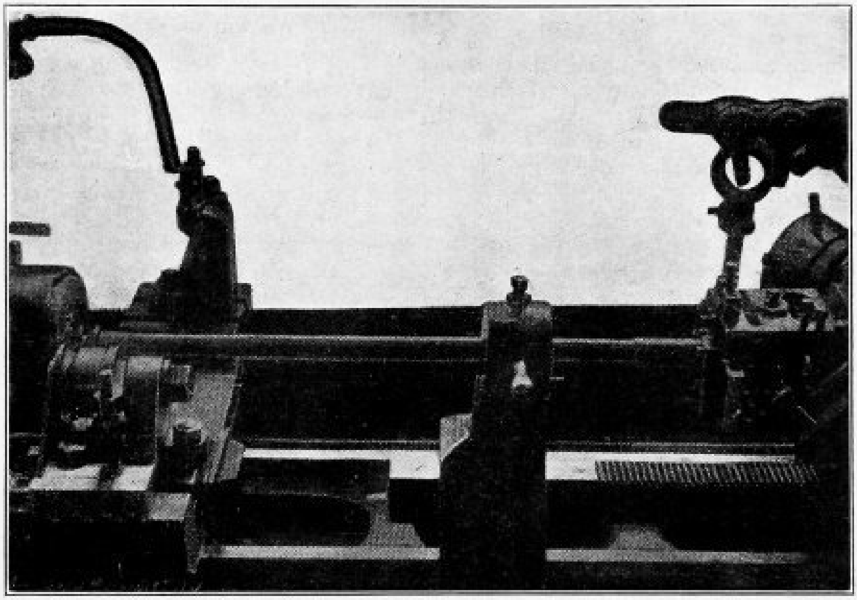


FIG. 1.—FINISHING A LONG STAY-BOLT IN A PRATT & WHITNEY OPEN-TURRET LATHE.

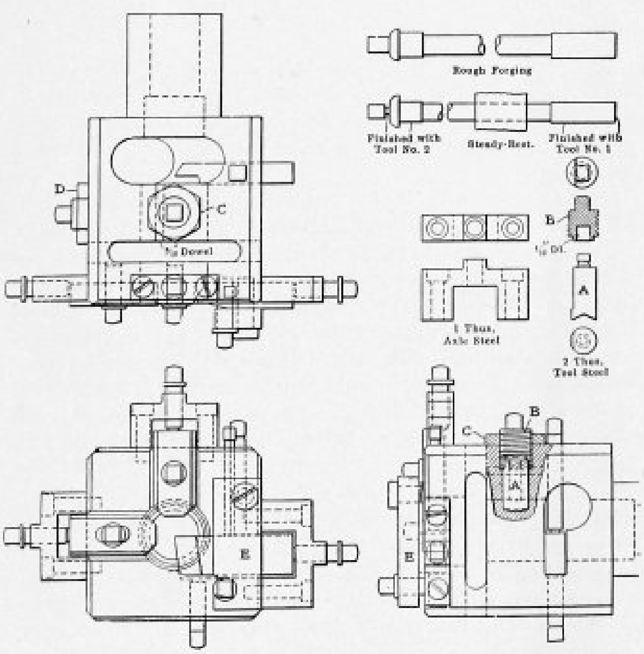


FIG. 2.—DETAILS OF BOX TOOLS.

those for the rear tool are cylindrical, as seen at *A*, the details showing the form and means of adjustment quite clearly. One face of jaw *A* is flatted, as indicated, in order to contact with the side of a pin driven in the holder, which prevents the back-rest jaw from rotating in its seat when adjusted by the threaded plug *B*. The latter is connected with the shank at the upper end of jaw *A* by a small pin driven in crosswise and fitting the half-round groove in neck *A*. When properly adjusted, screw plugs *B* are securely clamped by check nuts *C* and *D*. The method of adjusting and clamping the outer pair of back-rest jaws and the adjustment for the tool are clearly shown in the end view. This also illustrates the swinging strap *E*, which allows the cutting tool to be readily removed or replaced.

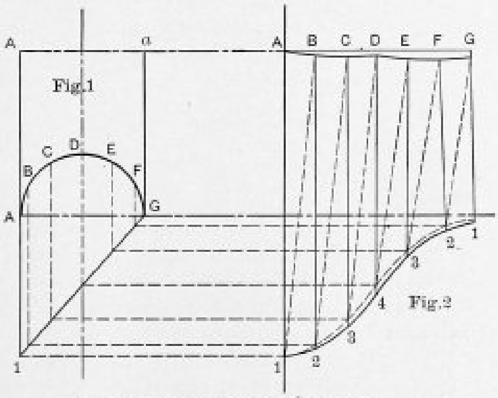
Engineer-in-Chief C. A. M'Allister, of the United States revenue cutter service, stated in the November issue of *International Marine Engineering* that if asked to name the most important rule as a maxim to be adopted by the man in charge of a Scotch marine boiler, he would unhesitatingly say, "Avoid sudden changes of temperature." From the first starting of the fires until the boiler has been allowed to cool off after a long period under steam this rule must be kept continously in mind.

LAYING OUT BY TRIANGULATION AND PARALLEL LINES.

BY J. N. HELTZEL.

In looking over some back numbers of THE BOILER MAKER I find a number of articles where triangulation is used, as a means of developing the patterns instead of laying out by parallel lines and projections, which would have been the proper method to use.

Mr. Linstrom's article on page 272 of the October issue of THE BOILER MAKER, describing the development of an irregular pipe connection, is a good illustration of a mistake in applying triangulation to a problem like this. The pipe is merely round and cut off at an angle, and can be laid out by parallel lines. I am certain that it is impossible to develop a pattern like this accurately by triangulation. As shown in Fig. 1, which is a reproduction of the pipe shown in Mr. Linstrom's article, it is obvious that lines *A*-1 and *G*-1 of pattern should be parallel, since this is a round object. Also line *A-G* is straight and at right angles to line *A*-1, as the pipe is cut straight on the end. The lengths of the parallel lines of Mr. Linstrom's pattern are right, but they do not terminate on the horizontal line *A-G*, consequently the contour of the sheet is incorrect, as shown on Fig. 2. The oval of the base can be drawn from the five intermediate lines, Fig. 1. It is necessary to use triangulation in the development of the base, since this has an irregular shape.



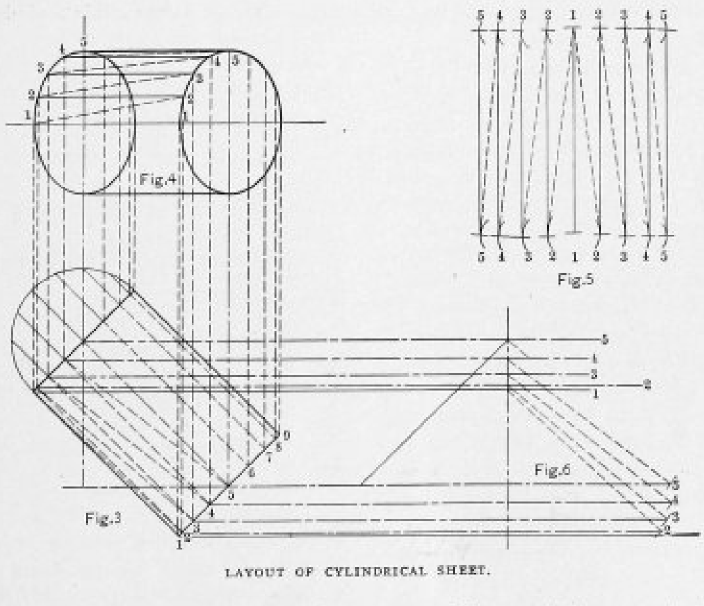
ROUND PIPE CUT OFF AT AN ANGLE.

I have shown here how easy it is to go astray in laying out by triangulation, and a little further on will endeavor to demonstrate the proposition, as I know it will be hard to convince the advocates of triangulation that the method is a very easy one in which to err, and is impractical in many cases, and should only be used when parallel projections or radial lines will not apply.

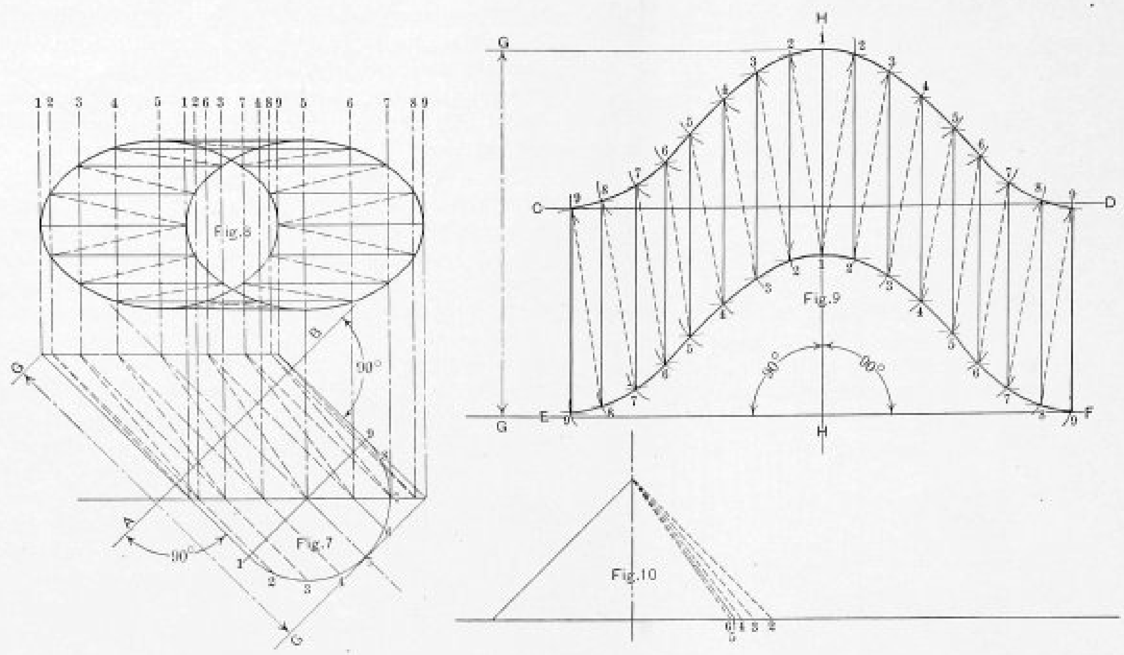
Figs. 3, 4, 5 and 6 represent the layout of a cylindrical sheet cut straight at both ends. The pattern for same would merely be a square sheet, Fig. 5. This is laid out by triangulation. I do not intimate that anyone would lay out a square sheet by triangulation, but only wish to show that the method covers a wide field, and can be applied to any problem but not with good results in all cases. The other illustrations show practically the same thing.

In Figs. 7, 8, 9 and 10 is shown the layout of the pattern of a cylinder cut off at an angle on both ends, the ends being parallel. This is a true cylinder through *A-B*, Fig. 7. Therefore, the proper method to use in developing the sheet would be by parallel lines, using *A-B* as a working line through the pattern. We will use triangulation on the problem and see how near we are to being correct. If we were to lay this piece out by parallel lines all that would be necessary would be Fig. 7; but by the other method it is necessary to draw Figs. 8 and 10. As many layouts by triangulation have been explained from time to time in THE BOILER MAKER, it is not necessary to go into detail in this case, but we will compare the pattern with one as it would be if laid out by parallel lines. First, we know that the width of the pattern *G-G*, Fig. 9, should be the same as *G-G*, Fig. 7. This is not the case here. Also, the parallel lines *E-F* and *C-D* should intersect all four corners of the pattern. This is not the case here. Another error is that the two lines 9-9, which are the seam or rivet lines, are not parallel. Then, too, we do not whether the length of our pattern is correct or not. For these reasons the use of triangulation to lay out a sheet like this is a mistake.

Having thoroughly covered the parallel lines and projections we will take up the layout of a cone by triangulation. Let us assume that Fig. 11 is a stack base of large dimensions, and we resort to the method of triangulation to develop the plates. The preliminary work in connection with this shape is less than is required in any other shape which has come to my notice, as we have only two lines to deal with. Fig. 12 is the plan view of the cone, but this view is not necessary, although for sake of convenience we will use it in this illustration. Fig. 13 is the developed sheet of seventeen spaces. The



LAYOUT OF CYLINDRICAL SHEET.



LAYOUT OF A CYLINDER CUT AT AN ANGLE.

reader will note the vast difference between the two curves at *D* and *D*. Also note the course of the line *X-X*, which should terminate at the apex *T*. It is obvious that the contour of this pattern is radically wrong.

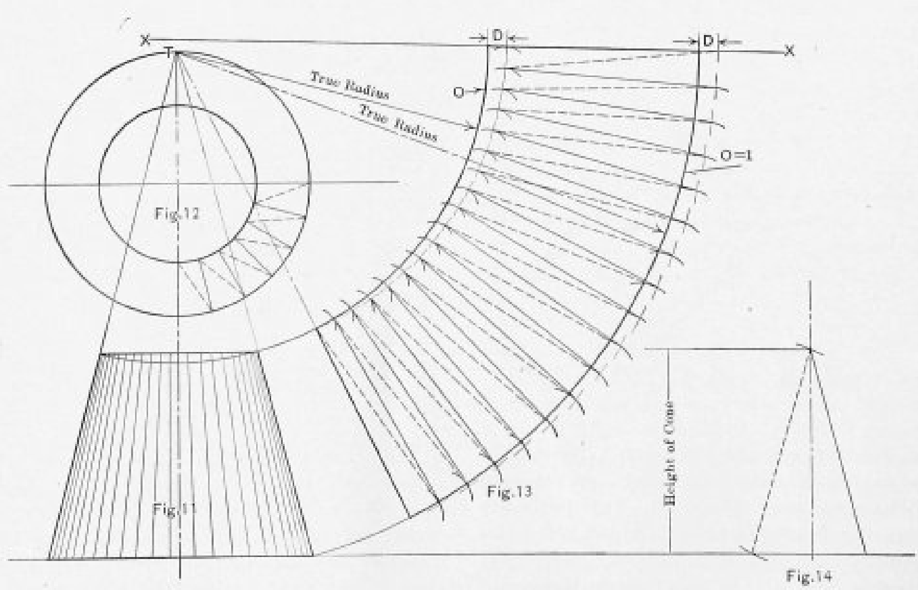
I am quite sure that the foregoing illustrations will convince the reader that triangulation should only be used in the development of irregular shapes and should not be used where any other method could be applied.

Very remarkable tenders have been applied to the Mallet compound locomotives recently built by the Baldwin Locomotive Works for the Atchison, Topeka & Santa Fe Railway, being far in excess, both as respects capacity and weight, of anything that has ever been built for locomotive use before. They have a capacity of 12,000 gallons of water, and the coal space is taken up by a tank with a capacity of 4,000 gallons of oil.

Locomotives Built in 1909.

According to the *Railroad Age Gazette*, the number of locomotives built during the past year is but a little greater than the 1908 figures, in spite of the improvement in general business conditions during 1909. However, it has really been but a few months since the railways came into the market with substantial inquiries; and deliveries on orders placed at the beginning of this movement did not begin until this fall. Late in 1908 a number of heavy orders were placed, but after that there was a lull until last June. Notwithstanding the increased traffic to be carried in 1909, railways were not in such vital need of new motive power as at certain periods of the preceding year. More locomotives were available for use.

Returns from fourteen locomotive builders in the United States and Canada (estimating the output of two small plants) show a total of 2,887 engines. Of the 2,653 built in the United



LAYOUT OF A CONE, SHOWING ERROR IN USE OF TRIANGULATION.

States, 2,362 were for domestic use and 291 for export. These figures include sixteen electric and 119 compound locomotives. The Canadian engines, 234, were all for domestic service.

Comparisons for the last seventeen years are given in the following table:

Year.	No. built.	Year.	No. built.	Year.	No. built.
1893	2,011	1899	2,475	1905	*5,491
1894	695	1900	3,153	1906	*6,952
1895	1,101	1901	3,384	1907	*7,362
1896	1,175	1902	4,070	1908	*2,342
1897	1,251	1903	5,152	1909	*2,887
1898	1,875	1904	3,441		

* Includes Canadian output.

A new type of superheater has been in service on the Santa Fe Railroad for more than a year, and the results have been such as to lead to its application to a very large number of locomotives.

LOCOMOTIVE BOILER INSPECTION.*

In our last annual report a full description was given of the system of boiler inspection inaugurated by the Commission to conform to the requirements of Chapter 208 of the laws of 1907, and the duties of the Commission as prescribed by that statute were fully outlined and need not be repeated.

The work of this department has been successfully carried on under the direction of the State Boiler Inspector during the past year without material change in this system.

The following are the principal statistics submitted in the report of the State Boiler Inspector:

1. Number of companies reporting inspections....... 99
2. Number of locomotives certified for use in the State 7,489
3. Number of such locomotives actually in service, Dec. 1, 1909.......... 6,478
4. Number of such locomotives temporarily out of service, Dec. 1, 1909.......... 1,011
5. Inspectors employed by railroad companies to inspect boilers (not including clerical help), about 550
6. Number of locomotives condemned or sold Jan. 1, 1909, to Dec. 1, 1909 (many locomotives reported temporarily out of service by company are undoubtedly out of service permanently). 245
7. Number of certificates of inspection filed Jan. 1, 1909, to Dec. 31, 1909, about.......... 30,000
8. Number of specification cards filed Jan. 1, 1909, to Dec. 31, 1909.......... 1,610
9. Number of specification cards filed Sept. 1, 1907, to Dec. 31, 1909.......... 7,724
10. Number of specification cards due.......... 10
11. Number of visits of inspectors to shops and offices Jan. 1, 1909, to Dec. 31, 1909.......... 283
12. Number of times boiler washouts were overdue, Jan. 1, 1909, to Dec. 31, 1909.......... 187
13. Number of days boiler washouts were overdue, Jan. 1, 1909, to Dec. 31, 1909.......... 2,907

The following record, showing the number of locomotives reported by each railroad in this State, indicates the relative importance of the roads to the State, so far as this part of the Commission's work goes. The table includes not only the locomotives constantly used in the State, but many which are used only occasionally and which are therefore reported under the boiler inspection law:

* From the third annual report, New York Public Service Commission, Second District, Garland P. Robinson, Inspector of Locomotive Boilers.

RAILROADS AND OTHER COMPANIES OPERATING FIVE OR MORE LOCOMOTIVES IN THE STATE, AS REPORTED TO THE COMMISSION DECEMBER 1, 1909:

NAME OF ROAD.	Total Boilers Reported to this Commission.	Number of Boilers in Active Service.	Number of Boilers Temporarily out of Service.	Total Number Locomotives Owned, used in this and Other States.
New York Central Lines: New York Central, Rutland, Michigan Central, Boston & Albany, LakeShore&MichiganSouthern	2,072	2,410	292	3,837
Erie	1,082	965	117	1,419
Delaware, Lackawanna & Western	597	553	44	770
Delaware & Hudson	459	423	36	471
Lehigh Valley	428	283	145	873
New York, New Haven & Hartford	334	274	60	1,226
Pennsylvania and Northern Central	309	267	42	4,094
Buffalo, Rochester & Pittsburgh	260	232	28	300
Long Island	185	173	12	185
New York, Ontario & Western	182	168	14	184
Boston & Maine	176	129	47	1,093
Grand Trunk	142	75	67	1,190
Buffalo & Susquehanna	78	74	4	78
New York, Chicago & St. Louis	66	57	9	230
Central New England	58	49	9	60
Wabash	50	29	21	657
Lehigh & Hudson River	47	39	8	47
Pittsburg, Shawmut & Northern	36	35	1	40
South Buffalo	33	30	3	33
Ulster & Delaware	31	30	1	31
Pere Marquette	24	11	13	451
Central Vermont	18	6	12	102
Hawkeye Construction Company	13	12	1	13
Buffalo Creek	12	11	1	12
Lehigh & New England	10	7	3	25
Toronto, Hamilton & Buffalo	10	5	5	21
Quebec, Montreal & Southern	7	6	1	17
Fonda, Johnstown & Gloversville	7	6	1	7
Greenwich & Johnsonville	7	6	1	7
Lake Champlain & Moriah	7	6	1	7
American Locomotive Company	6	6	0	6
Delaware & Eastern	5	5	0	5
Jamestown, Chautauqua & Lake Erie	5	5	0	5
New York & Pennsylvania	5	5	0	5
Solvay Process Company	5	4	1	5

As the total number of locomotive boilers in use in the United States is about 57,000, it will be noted that about one-eighth of the total come under the supervision of this Commission in the performance of its duties in the administration of the boiler inspection law.

As there are but two experts employed in this department of the Commission's work, the State Boiler Inspector and his assistant, it is impossible to exercise more than a general supervision over the inspection of this number of locomotive boilers, and the work of the department has therefore been confined mainly to the checking of the reports and specification cards received from the railroads, and in exercising a general supervision over the inspectors who are designated by the railroad companies for this work. It is entirely impossible for the inspectors of the Commission to make detailed examinations of any considerable number of locomotive boilers, and this is only done in special cases to check the work of railroad inspectors whose reports are doubtful.

Two hundred and eighty-three inspection trips have been made to points where boilers are inspected and where repairs are made by the railroad companies. On these trips a general examination has been made of about 2,350 locomotives. The principal results of the inspection trips are as follows:

Number boilers reported for service Dec. 31, 1909......	7,604
Number boilers inspected by State Inspector..........	2,350
Number trips of inspection..........	283
Number places where inspections are made..........	295
Number boiler defects reported..........	1,147
Number defective water glasses reported..........	51
Number defective gage cocks reported..........	56
Number defective steam gages reported..........	17
Number broken stay-bolts reported..........	977
Number broken stay-bolts found with tell-tale holes plugged	138

Number boilers found with tell-tale holes in stay-bolts filled with paint	46
Number of boilers found with either no certificate or certificate improperly posted in cab	27
Number boilers found with serious leaks	26
Number boilers found with cracks in barrel	4

A number of cases of corrosion have been noted which were principally confined to the fire-box and flues, and were, therefore, not especially dangerous. In one case, however, the plate was found corroded the entire length of the barrel of the boiler and for 15 inches on each side of the center. The plate was originally ½ inch in thickness, and had been corroded until the thickness had been reduced to 3/16 of an inch.

Other defects which have been noted are as follows:

Several cases have been found of broken longitudinal stays and crown-bar braces, and in one boiler a majority of the brace pins were found to be bent and the brace jaws spread. One boiler had a crack in the barrel 4 inches long which had been repaired by plugging with small plugs instead of patching properly. A serious leak developed at this point, and the boiler was ordered out of service in consequence. One boiler was found with a crack 21 inches long in the barrel, and another with a crack about 3 feet long in the lap seam.

The practice of investigating all important accidents to locomotive boilers has been continued. The following record is given of all accidents reported for 1909, together with the record of 1908 for comparison:

SUMMARY OF ACCIDENTS INVESTIGATED:

Number of Accidents.		Cause of Accident.	Number Persons Killed.		Number Persons Injured.	
1908.	1909.		1908.	1909.	1908.	1909.
1	0	Pocket flue blew out	0	0	1	0
1	0	Arch tube burst	0	0	1	0
4	0	Plugs and studs blew out; nuts stripped	0	0	4	0
1	0	Burst flue	0	0	1	0
1	1	Flue pulled out	1	0	1	1
11	4	Low water	8	6	14	6
0	1	Broken staybolts	0	0	0	1

SUMMARY OF ACCIDENTS WHICH HAVE NOT BEEN INVESTIGATED.

No. of Accidents.		Cause Given by Company.	Injured.	
1908.	1909.		1908.	1909.
1	5	Water glass burst	1	5
2	1	Stud blown out and nuts stripped	2	1
2	0	Flue burst	2	0
1	0	Low water	1	0
		Total number of accidents	25	12
		Total number of persons killed	9	6
		Total number of persons injured	28	14
		Total number of locomotives in service	7,466	7,604

	1908	1909
Ratio of accidents to locomotives in service	1 to 299	1 to 624
Ratio of persons killed to locomotives in service	1 to 829	1 to 1,267
Ratio of persons injured to locomotives in service	1 to 266	1 to 543

The above record shows a decided decrease in boiler accidents for the year 1909, as compared with the previous year, especially in accidents due to low water. It is believed that the reduction in low-water accidents has been due to a considerable extent to the improvement in the inspection of water glasses, gage cocks and injectors.

As stated in the last annual report, a specification card is required for each boiler used in this State. This card gives the principal dimensions of the boiler and the essential data necessary for determining the factor of safety; 7,724 of these cards have been received, and all have been checked. In the last annual report a summary was given of the results of tabulation of these cards for 6,114 boilers which had then been examined. Some changes in the system of classification then proposed have been suggested, and the 7,724 boiler records now on file have been reclassified according to the following proposed standards:

PROPOSED FACTORS OF SAFETY.

		Factor.
1.	Boilers with butt seams, under 30 years	4
2.	Boilers with lap and cover seams, under 20 years	4
3.	Boilers with lap and cover seams, 20 to 30 years	4¼
4.	Boilers under 20 years old with plain lap seams	4¼
5.	Boilers with plain lap seams, 20 to 30 years	4½
6.	Boilers 30 to 40 years old	5
7.	Boilers over 40 years old	to be condemned.

The following are the principal results of this classification.

NUMBER OF BOILERS WHICH DO NOT MEET THE PROPOSED STANDARD.

Number of boilers, butt seams under 30 years, factor less than 4	60
Number of boilers, lap and cover seams under 20 years, factor less than 4	54
Number of boilers, lap and cover seams 20 to 30 years, factor less than 4¼	47
Number of boilers, lap seams under 20 years, factor less than 4¼	175
Number of boilers, lap seams 20 to 30 years, factor less than 4½	108
Number of boilers, any seams 30 to 40 years, factor less than 5	13
Number of boilers over 40 years	2
Number of boilers of unknown age	6
Total	465

REDUCTION OF PRESSURE NECESSARY TO COMPLY WITH PROPOSED STANDARD.

Number of boilers to have pressure reduced 5 pounds	39
Number of boilers to have pressure reduced 10 pounds	95
Number of boilers to have pressure reduced 15 pounds	140
Number of boilers to have pressure reduced 20 pounds	71
Number of boilers to have pressure reduced 25 pounds	32
Number of boilers to have pressure reduced over 25 pounds	80
Total	457

The proposed standards above given have been submitted to all companies and their full criticism requested. Replies from all have been received. The suggestions meet with the approval of the majority of the roads, and while they are criticised by others, it appears probable that no standards could be fixed which would not meet with fully as much opposition. In the matter of lap seam boilers, for instance, one large road states that no additional factor of safety is required beyond that necessary for boilers with modern seams; and another equally prominent road states that lap seams should be prohibited by law.

Most of the companies have agreed to comply with the suggestions of the Commission, and to condemn or strengthen doubtful boilers or to reduce pressures, and it appears probable that this entire subject can be settled to the satisfaction of the Commission without the necessity of formal hearings or the issuing of orders. The company which happens to have the largest proportion of locomotives which will be affected by the proposed standards, and which will therefore be subjected to the greatest expense for any changes which may be decided upon, writes:

"The minimum factors of safety as indicated by you seem to be reasonable, and there is no engineering data or authority that will justify any recommendation for a lower factor than that suggested by the Commission."

Railroad officers are keenly interested in all measures calculated to increase the safety of locomotive boilers, and there has been but little difficulty in securing their full co-operation in this work.

The number of boilers having low factors of safety is being rapidly reduced, largely at the initiative of the companies themselves. This is shown by the fact that on Jan. 1, 1909, the records of the Commission showed that 963 boilers had a factor of safety of less than 4, while on Dec. 1, 1909, the records show only 369 boilers with low factors of safety, or a reduction in doubtful boilers of 62 percent in eleven months.

Much attention has been given to the question of design of boiler bracing, both by the Commission's inspectors and by the mechanical engineers of the railroad companies. As a result, some of the boilers having high stress in braces have been condemned, and many have had the braces reinforced.

The chief boiler inspector reports, that while the systems of inspection of boilers used by railroad companies are in general reasonably satisfactory, he believes that considerable improvement would be made if all companies would adopt the practice in use by some of the roads of placing all of the subordinate boiler inspectors under a chief inspector and confining the work of the subordinate inspectors, where the volume of business will permit, entirely to inspection.

Increased attention by the railroad companies has also been advised in the training of their boiler inspectors to detect broken stay-bolts. It has been found that many of the railroad inspectors are not as well qualified as they should be to make satisfactory stay-bolt tests, and competitive trials of inspectors under the supervision of experts has therefore been recommended.

The experience of the last two years has, we think, demonstrated the value of this part of the Commission's work, and has proved, we believe, that the systematic checking of the railroad companies' inspectors and inspection systems will, if properly carried out, give satisfactory results. The appointment by the Government of detailed boiler inspectors to duplicate or supersede the inspection work now carried on by the railroads would have the disadvantage of relieving the railroad companies of at least a portion of the responsibility which properly belongs to them, and in addition would be vastly more expensive than the present system.

POWERFUL AND ECONOMICAL BOILER.

On a road where fuel is cheap and good the boiler should be designed with reference to power, and no especial attention should be paid to efficiency, unless the efficiency is so low that the boiler has to be forced to the extent that the fire-box sheets are damaged and the repairs too much increased. Let us consider what constitutes the most powerful boilers.

In the first place, the grate must be as large as possible, because more fuel can be burned in a large fire-box than in a small one. It is self-evident that the more coal that can be burned effectively in a given time, the greater evaporation we should expect. In the second place, the crown sheet must not be too far from the fire, and lastly, the tubes should be short and large in area of opening, so as to offer a free passage to the gas. A 2½ or 3-inch tube will give more power than a 2-inch tube, but good practice limits the diameter of tubes to 2¼ inches. The maximum power is obtained when the blast is as strong as possible to get it without tearing the fire in starting, and without causing excessive back pressure in the cylinders. When power is the only requisite, the above combination will give it.

The most powerful boilers applied to locomotives are those of the modified Wootten type, with 75 to 100 square feet of grate area and tubes about 15 feet long and 2 inches in diameter. Many engines of this class are in service on the Lehigh Valley and the Delaware, Lackawanna & Western. In passenger service, most of these engines are fired with anthracite coal, but in the freight service bituminous coal is used. The large ten-wheel passenger engines on the Delaware, Lackawanna & Western are capable of developing 2,000 horsepower. They have, perhaps, the most powerful boiler yet applied to any locomotive. The fire-box has a heating surface of 228½ square feet and a grate area of 103.8 square feet. There are 398 tubes, 15 feet 3 inches long, which provide a heating surface of 3,158.5 square feet. The most remarkable feature of these engines is the grate area—103.8 square feet. The ability to produce great horsepower per square foot of heating surface is obtained by the enormous grate surface available for the almost perfect combustion of the fuel.

With a large grate area a less violent exhaust will supply the air necessary for combustion, and therefore the Wootten boiler of equivalent heating surface will always develop greater horsepower than the narrow fire-box. The violence of the exhaust is, in a measure, regulated by the area of the grate. Here it might be said that a variable exhaust would make it possible to increase the power of a boiler, for with it the violence of the exhaust in starting could be reduced, and thus holes would not be torn in the fire.

We have considered what constitutes the most powerful boiler, and now it is in order to decide as to the most economical boiler. The most econmical boiler must have just as large heating surface as possible, especially in the fire-box, and the combustion must be slower; that is, combustion must be nearly perfect, and with the present method of getting air to the fire perfect combustion can only be obtained with slow combustion. When the rate of combustion is high, the mere passage of the air through the fuel does not give an adequate mixing, when high efficiency is wanted. This is the reason, above all others, why forcing a boiler reduces its efficiency, and is the reason why an engine with a small grate area, when forced, does not give the efficiency of a larger grate in which the coal is burned slower and the air has more time to mix with the fuel. It is evident that in a small boiler, that is, one in which a large amount of steam has to be generated in proportion to the heating surface, the fire must be urged; and therefore, the smaller the boiler in proportion to work it must do, the less will be its economy. The rapid combustion in a small boiler is produced by a contracted nozzle, with the result that the back pressure on the piston is very much increased; the violent blast also causes considerable unconsumed coal to pass through the flues, and, due to the greater velocity of the gases, they are in contact with the heating surface a shorter length of time. This has its influence in reducing economy. No locomotive boiler is too large for economy if the above is true. Hence, passenger locomotives for hauling heavy trains at high speeds should have boilers as large as the weight of the locomotive will permit.

The Atlantic and Pacific type engines generally have the most economical boilers. It is not uncommon for an engine of the Pacific type to have 2-inch flues 20 feet long, with 50 square feet of grate area. On through runs, where the trains are heavy, there is no loss from the large grate area.

From what has been said above, we see that both the most powerful and the most economical boilers must have all the fire-box heating surface possible, and as much tube heating surface as can be obtained without interfering with the draft. Therefore, the size of the tubes, and the fire part of the grates, are the only differences which enter in actual construction.

One fundamental design will answer for both by getting as large a fire-box and as large a shell as the total weight will permit, and then perhaps brick off the grate in the most economical boiler and use the whole of it in the most powerful boiler. As an example, the class E 3-a, Atlantic type engines on the Pennsylvania have what might be considered a powerful boiler. They have 315 tubes, 2 inches in diameter, and 55½ square feet of grate area. On the Atlantic City division the runs are short, and an economical boiler is able to handle high-speed trains. For that reason a part of the grate near the flue sheet is bricked off, leaving an effective area of about 40 square feet. On the New York division, however, the service is more exacting, and the same type engines are run with the entire grate area effective, that is, 55½ square feet. In both cases the fire-box heating surface is retained.—W. Smith, in *Railway and Locomotive Engineering.*

LAYOUT OF A 90-DEGREE TAPERING WAGON-TOP BREECHING.

BY C. B. LINSTROM.

In the construction for power houses, for either power or heating purposes, it is necessary to locate the boilers and machinery within a certain limit of floor area, and to the best advantage within the limits allotted for that purpose. From the above it is evident that in order to meet some of the conditions encountered various arrangements and constructions must be introduced. The casual observer will notice in visiting various power plants that there are innumerable sizes and shapes of boiler settings, breechings, stacks and chimneys, etc. These are some of the potent factors entering into the question of obtaining the proper combustion of fuel.

Many items must be taken into consideration in designing these respective essentials, especially where a number of boilers are connected together, forming what is commonly termed a "nest." The main requisites entering therein depend largely upon the size and number of boilers installed, horsepower to be generated, nature of fuel and rate of combustion.

The subject under consideration in this article is the construction of the smoke conveyor. A form sometimes used is shown in the plan and elevation of Fig. 1. However, the best practice, if conditions permit, is to make the connection straight, as this will promote a better passage for the gases. Fig. 1 shows sections that are tapering and within the limits of a 90-degree angle. The reasons for tapering the conveyor is to obtain a construction as cheap as possible within the bounds of good work and to promote a good circulation of air throughout its entire length, as it is obvious that allowances must be made to take care of the gases, which increase proportionally to the number of furnaces feeding into the smoke-box. The draft required depends largely upon the nature of the fuel and rate of combustion needed for generating the horsepower.

In designing smoke conveyors of this character it is good practice, and it should be the aim of the designer to provide for an excess of the required demands, and then regulate the draft by dampers to meet the requirements.

As stated previously, Fig. 1 represents the plan and elevation of the smoke breeching. The method of development applicable for its entire solution is the method of projection drawing. The view to the left of the elevation represents the respective cross sections taken through *A*, *B*, *C*, *D* and *E*. The construction of this problem is very easily understood, as it does not involve any complicated drawing.

First, draw the lines *K-L* and *K-O* at right angles to each other. With *K* as an apex and the trammels set equal to the outside radius *K-L*, describe an arc within the limits of the lines *K-O* and *K-L*. Then with the dividers set equal to the inside radius, and using *K* as a center, draw an arc in a like manner. Divide the inside or outside arc into any number of equal spaces, and arrange the spaces so that there will be at either end a half space; connect the points of division on the arc with the apex *K*, which locates in the plan view the division lines for the respective sections *A*, *B*, *C*, *D* and *E*. At either end of this view locate the profile as shown; draw the semi-circle with a radius equal to one-half the diameter of the conveyor. Divide its periphery into any number of equal spaces, and project these points of division until they intersect the line *K-L*. With *K* as a center, and the dividers or trammels set to these respective radii, draw arcs through to *K-O*. Connect these points of division where they intersect the division line of the section with straight lines. The next step in the construction is the development of the elevation, which is readily executed in the following manner: At right angles to the line *K-L* extend the outer boundary of the plan view to the elevation, and make the length of the lines indefinite. Upon the line *K-O* locate the required height of the breeching and also the pitch, which is the amount of taper for each section. It is customary to make the pitch equal per section, excepting the end sections, which are equal to one-half the inner sections. To determine the pitch for each section, divide the distance *R* into as many equal and half spaces as contained in the plan view.

Since the construction of the respective sections in this view involves practically the same operations for each one, a description in detail of the various operations for the development of each section will not be given, as an explanation for one of the divisions will be sufficient in order to understand the necessary method of drawing applicable for their development.

Section *E* will be used as an example: To the left of the elevation draw a profile of section *E*, make its height equal to 1 and its width equal to the distance *N-O*. Bisect the width of the profile and draw the center line. Upon this line, and with the dividers set equal to the radius of the profile plan view, and through point 1 of this section draw the semi-circle, as shown from 1 to 4. Divide this view into the same number of equal spaces as contained in the profile plan view.

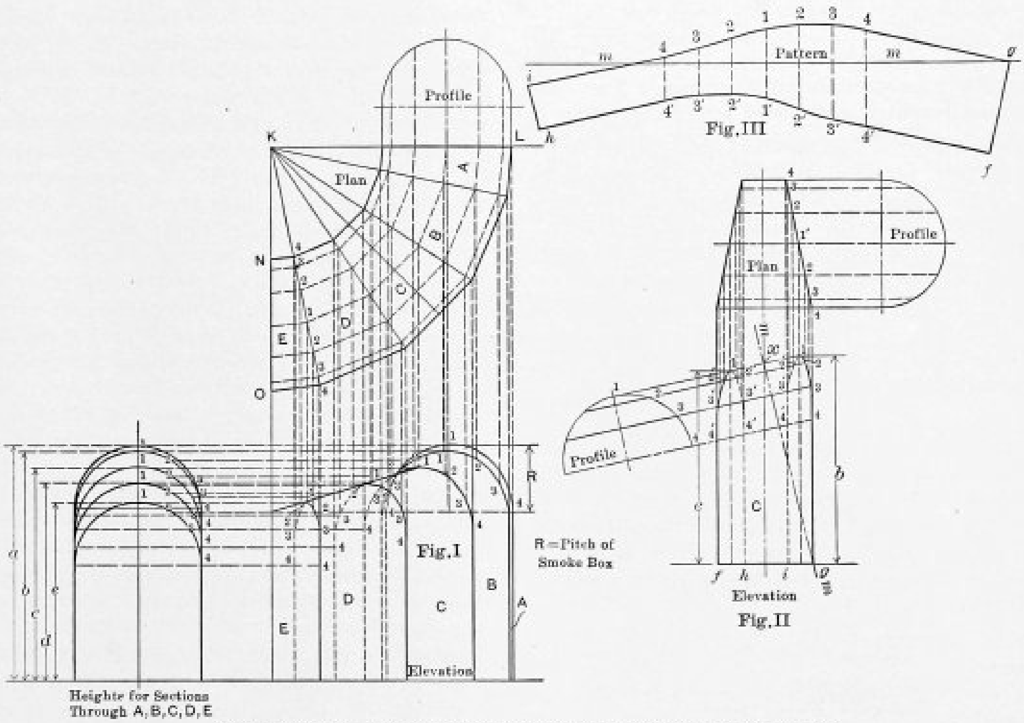
Through these points and at right angles to the line *K-O* extend the projectors through the section *E*. Drop the corresponding points from the plan view parallel to the line *K-O* until they intersect the projectors, drawn from the corresponding view to the left of the elevation. A line traced through the intersection of these lines determines the foreshortened view of that section shown in the elevation. The operation of developing the divisions *A*, *B*, *C*, *D* and *E* is not essential, as sufficient data for developing the pattern can be obtained from the profiles and the plan view.

Fig. 2 represents the plan and elevation of section *C*, which is a section taken through the center of the smoke-box. Draw the plan view first, and make it equal to the dimensions as given in the plan view, Fig. 1. Through its center draw the line 1′, indefinite in length; locate upon it the profile, which is drawn to the same radius, as shown in Fig. 1. Divide its circumference into the same number of equal spaces, and project the points of division parallel with line 1 through the plan. At right angles to line 1, and below the plan view, locate the elevation for this section.

Make the major height equal to *b* and the minor to *c*, which are obtained from the cross-sections shown to the left of the elevation, Fig. 1. Connect the heights *b* and *c* with the line 1-1, and make it of a convenient length. At right angles to this line draw the center line of the profile. Upon it locate the center for describing the arc. Parallel with line 1-1, and through the point just located, draw the line 4-4. Divide the circumference of the profile into the same number of equal spaces as are contained in the arcs previously drawn. Through these divisions and parallel to the line 1-1, or 4-4, draw projectors through to the elevation. Where these lines intersect the lines dropped from the plan determines the foreshortened view for the circular miter line.

At right angles to the line 1-1, and through the point *x*, which is the point of intersection between 1-1 and the center line *C*, draw the line *m-m* through the elevation. This line we will term the base line, as it will be used for determining the pattern. Sufficient information has now been given in order to proceed with the development for the pattern.

Referring to Fig. 3, draw the stretch-out line, or base line *m-m*, and at right angles to it draw the line 1′-1′. On either side of this line locate the points 2, 3 and 4. These are equal



DEVELOPMENT OF THE PATTERNS FOR A TAPERING WAGON-TOP BREECHING.

to the chord distances of the spaces taken from either profile. The actual distance, however, is equal to the length of each arc, but for all practical purposes the chord distances are sufficiently accurate. It is well, where greater accuracy is required, to divide the profile into as many equal spaces as possible, so long as it is within the bounds of good practice. This will insure a more correct pattern.

The camber line, or miter line for the cirular portion of the section, is within the limits of the points 4-4′. The operation of transferring the respective true length of lines from the elevation to the pattern does not involve any complicated procedures. The lines from *m-m* to 1, 2, 3 and 4, and *m-m* to 1′, 2′, 3′ and 4′ are the required or true lengths of lines to be used in developing the top or irregular portion of the pattern. The distances from 4 to *g*, 4 to *i*, 4′ to *f* and 4′ to *h* are the true lengths of lines for the straight portion of the smoke-box.

Smoke-boxes of this character are generally made of 10 or 8-gage sheet iron, and are also braced with angle-irons on either side, which are located in the center.

Average Age of Locomotives, as Indicated by Boiler Inspection Records.

The specification cards which are filed with the Public Service Commission, Second District, New York, for locomotive boilers, give the data needed to make a fair estimate of the average age of locomotives which are used either constantly or occasionally in this State, and which therefore come under the jurisdiction of this Commission. The total number of locomotives so used is 7,604, and the average age of these locomotives, as shown by the following table, is a little under nine years.

The table gives the number of locomotives and average age of all roads which report fifty or more locomotives. The figures, of course, show only the average age of locomotives used in this State, and in some cases do not give a correct indication of the average age of the locomotives owned by the entire line. For instance, the Grand Trunk, which reports 142 locomotives of an average age of over fifteen years, operates only an unimportant line in this State, upon which locomotives of the older type are used almost exclusively. The system, as a whole, would no doubt show a very much better comparison with the other roads reported.

Average age of locomotive boilers in service Jan. 1, 1910, on railroads having fifty or more locomotives:

ROAD.	Number of Locomotives in Service.	Average Age.
Boston & Maine	187	7.0
Buffalo, Rochester & Pittsburgh	257	8.6
Buffalo & Susquehanna	76	6.2
Central New England	59	10.4
Delaware & Hudson	466	9.0
Delaware, Lackawanna & Western	580	9.2
Erie	1,120	12.5
Grand Trunk	142	15.1
Lehigh Valley	345	12.2
Long Island	187	10.7
New York Central Lines	2,815	7.8
New York, Chicago & St. Louis	68	6.6
New York, New Haven & Hartford	336	8.3
New York, Ontario & Western	178	10.1
Pennsylvania	333	7.8
Wabash	51	12.9
Above Roads	7,230	8.84

Average age of locomotive boilers in service Jan. 1, 1910, on railroads and manufacturing companies having less than fifty locomotives:

	Locomotives.	Average Age.
67 railroads and companies	375	10.5
All railroads in State	7,604	8.94

The boiler inspection records show the following distribution of locomotives, according to age, on Jan. 1, 1910:

Number under 10 years of age	4,783
Number 10 years and under 20	2,040
Number 20 years and under 30	715
Number 30 years and under 40	58
Number 40 years and over	8
	7,604

The number of new locomotives put in service on New York State lines in the year 1909, and used either constantly or occasionally in the State, is indicated by the boiler inspection records as follows:

Adirondack & St. Lawrence	1
Boston & Maine	20
Buffalo, Rochester & Pittsburg	14
Catskill Mountain	1
Central New England	3
Delaware, Lackawanna & Western	41
Glenfield & Western	1
Johnston Harvester Company	1
Lehigh & Hudson River	1
Lehigh Valley	4
New York Central Lines	34
New York, Chicago & St. Louis	5
New York, Ontario & Western	6
Solvay Process Company	1
Tonawanda Iron & Steel Company	1
Total number of new locomotives installed by railroad companies or by manufacturing plants and used occasionally on railroad companies' tracks during the year 1909	134

This may be compared with similar totals for previous years as follows:

Year 1909	134
Year 1908	417
Year 1907	791
Year 1906	722
Year 1905	772
Year 1904	533
Year 1903	504
Year 1902	525
Year 1901	385
Year 1900	427

Boiler-Ferrule and General Bush Extractor.

The line drawing herewith illustrates a useful appliance designed for the purpose of extracting ferrules from smoke tubes of locomotive, traction and portable boilers. It has been designed with the object of providing a superior method of extracting ferrules to that which is in vogue in some repair shops (in which they are driven out with a hammer and long, steel drift), and also of furnishing the boiler repairer with something better in the way of a mechanical extractor than those now in use.

The tool shown will be found to be a sound contrivance, inexpensive to make, and a good tool to have around when ferrules require to be hustled out. Being furnished with a ball thrust, as shown, the operator is relieved of a considerable amount of the labor usually accruing to ferrule extracting.

I have introduced this tool into several shops, and users speak well of it. For bush drawing, where "the other side" cannot be got at by the usual means, this extractor will easily do the job.

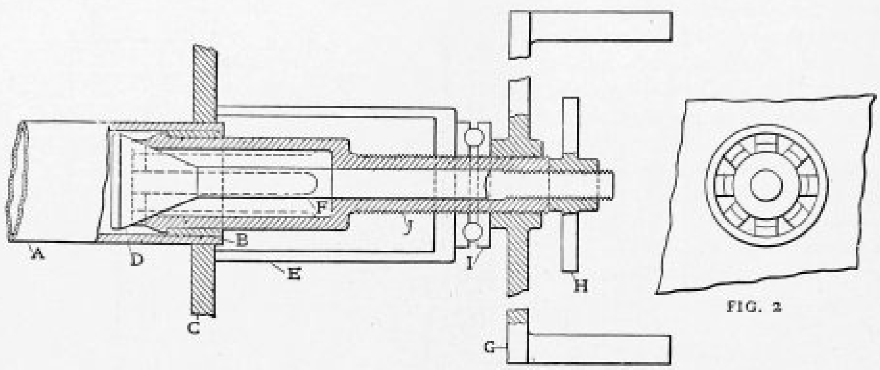


FIG. 2

FIG. 1.—BOILER-FERRULE AND GENERAL BUSH EXTRACTOR.

Fig. 1 illustrates the appliance. *A* is the boiler tube (2½ inches external diameter), *B* is the ferrule which has to be extracted, while *C* represents the tube plate of either the fire-box or smoke-box end of the boiler, *D* is a mold steel core, forged or turned in one with the shank *F*. *E* is a mild steel or malleable iron bridge piece, with a gap in one side, so that it may be put in position or taken off without taking off the handles *G* and *H* and the ball thrust *I*. *J* is the main thread by which the ferrule is extracted by rotating the double handle *G*.

Fig. 2 illustrates an end view of the tube *A*, ferrule *B*, and the eight spring prongs into which the end of the extractor *J* is divided. To use the appliance, slack out both handles *G* and *H*, push the divided end of the extractor through the ferrule *B*, when the eight ends of the extractor will return to their normal position, as shown in sketch.

By screwing up handle *H* the cone *D* will be drawn tightly into the extractor, preventing the eight "snacks" from being pressed off the edge of the furrule. It is then only necessary to rotate the main handle *G*, screwing the threaded part on to the twelve-thread screws *J*, and, let the ferrule be corroded ever so tightly, it will be easily extracted.

The extracted ferrule may be taken off the extractor by squeezing the eight parts with the hands, when the ferrule will fall off.—Joseph T. Towlson, in *The American Machinist*.

In laying out stack work never use less than a ¼-inch rivet in any sheet, nor a rivet of less diameter than the thickness of plate through which it passes. The pitch of rivets should vary from two and one-half to five times their diameter, depending upon the nature of the work.

BOILER-MAKING IN SCOTLAND.

An uneventful year in boiler making in Scotch works is reported by the Glasgow *Herald* in its annual industrial and commercial review. The *Herald's* column on the boiler-making industry is as follows:

Of all industries boiler making, it may be affirmed, is nearest the base of modern industrial activity. Since the days of James Watt the growth of the use of steam has been phenomenal; indeed, the commercial progress of the industrial world has coincided with the development of steam power. It may also be freely stated that despite recent discoveries the probability is, so far as human discernment can foresee, that steam for years to come will remain the principal power-producing medium. This important industry in all its branches is nowhere more strongly represented than in the West of Scotland. The manufacture of watertube boilers, both for land and naval requirements, has its headquarters at Renfrew; the well-nown Yarrow boilers of the small tube express type, for use on battleships, cruisers, destroyers, torpedo boats, etc., are built at Messrs. Yarrow's new works, Scotstoun; further, Clydeside has invariably held an honorable and almost unassailable place for its Scotch marine boiler, familiar in every mercantile marine, a position it is likely to maintain in spite of all competitors; and lastly, mention must be made of the deservedly high reputation of numerous firms in Glasgow and district engaged in the building of single and two-flued cylindrical, horizontal boilers, known in the trade as Cornish and Lancashire, both for home use and export.

The boiler industry therefore, more than any other, may be regarded in one sense as a barometer; it is one of the best of evidences as indicating the expansion or otherwise of engineering and commercial activities. As regards the home trade, it has to be recorded that the said barometer has displayed a falling tendency throughout the year. The complaint is general that 1909 has proved one of the worst of business years, while the outlook is by no means too promising.

LANCASHIRE BOILERS.

Notwithstanding the advent of and growing increase in the use of producer and suction-gas plants, the electric motor, etc., the Lancashire boiler still remains the favorite for factory purposes. Its ample steam capacity, its simplicity and general reliability, its accessibility for thorough examinations, now requisite under the Factory and Workshop Act, these features have continued to appeal to the mill owner with such success that, in spite of the advantages of newer types of steam raisers, mill owners in general are loth to abandon their confidence in what has hitherto been regarded as a well-tried friend.

With the gradually increasing adoption of high steam pressures, rising from 120 pounds up to in some cases 200 pounds per square inch, the difficulty of effectually staying the end plates of boilers of large diameter, so as to avoid the risk of grooving, has been a matter of much consideration among engineers. The adoption in recent years, however, of the system of "link" staying in preference to rigid staying has become much more general, and close observation in numerous and varied instances shows that this system has been wholly successful in overcoming what has hitherto been a decided trouble, if not danger.

Messrs. Penman & Company, Caledonian Iron Works, Glasgow, in their report, state that while they have been able to keep their works fully employed the greater part of the year, business generally has been dull, though the year ends with a somewhat brighter outlook, inquiries being more numerous.

Messrs. William Wilson & Company, Lilybank Boiler Works, Glasgow, state that their experience, with the exception of their export trade, has been unsatisfactory throughout the year, as on account of general depression, wherever it was not impossible, firms delayed renewing or increasing their plant.

VERTICAL BOILERS.

The electric motor has been the relentless enemy of vertical boilers at small works in all the large centers of industry. Formerly where hundreds of this class of boiler were in daily use they may now be counted by tens, users having quickly found the electric motor more convenient and suitable from nearly every point of view; hence the building of vertical boilers for small individual works has dropped to a minimum. On the other hand, the demand still continues from railway and public works contractors for such boilers, and likewise a fair demand for export.

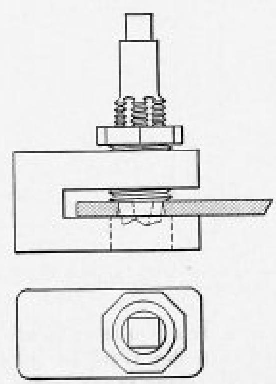
WATERTUBE BOILERS.

The leading firms in this branch have found the year a quiet one as regards home work, while on the other hand the foreign demand has been quite up to the average.

During the year Messrs. Yarrow & Company (Ltd.) have completed the transference of their entire works from Poplar to Scotstoun. The establishment at Scotstoun was fully equipped at the beginning of the year.

A Useful Tool for Tapping Holes for Patches.

The illustration shows a useful tool designed and used by the writer for tapping holes for patches. The construction of the tool is evident at a glance, and the method of using it is as follows: Put the clamp over the hole and screw the tap up by hand as far as possible. Tighten the check nut with a



DETAILS OF TOOL FOR TAPPING HOLES FOR PATCHES.

spanner, and tap with a reversible motor. By the use of this tool there is no danger of the tool being tapped off the square, or of the stripping of threads. Also by having a facing tool adapted to a drill press, it dispenses with the hand facing, thus insuring better results, with a saving of time and labor.

WILLIAM HENRY,
Foreman Boiler Maker, Canadian-Pacific Railroad.
Vancouver, B. C.

A short, approximate method of determining the total heating surface of a boiler with sufficient accuracy for ordinary purposes is to figure the heating surface in the tubes and divide it by .85 for a return tubular boiler, or by .90 for a watertube boiler. In case the return tubular boiler has an arch over the top for gas passage, giving a so-called third return, it is necessary to add from 100 to 200 square feet to the result to obtain the total heating surface.—*Power and the Engineer.*

THE LOCOMOTIVE BOILER FROM A PURELY PRACTICAL POINT OF VIEW.

BY LESLIE MC LAREN.

Much is written on the virtues of this or that particular type of locomotive boiler, but it will be observed that the relative differences are nearly always discussed more from the theoretical than from the purely practical point of view; having more regard to the actual life of the boiler or the frequency of its visits to the workshops for repairs than to its actual efficiency in the generating of steam, at any rate from the point of view of the man on the foot plate, who, of course, may be reckoned on as having something worth saying on the subject if he could only be persuaded to say it.

The writer, who is certainly more concerned with the boiler in practice than with the design or construction of it, does not propose at present to cross swords with any of the contributors to THE BOILER MAKER as to what type of boiler may be regarded as the most suitable for railway practice. His intention is merely to make, in as few words as possible, some observations on the locomotive boiler from an engineman's point of view, and especially with regard to the smoke nuisance, and the emission of sparks from the chimney; two matters that have been receiving considerable attention on British railways for some time back.

The passing of the Railway Fires Act of 1905 makes the railway companies now liable for compensation in case of damage to agricultural land or to crops that has been caused by fire through sparks or cinders from railway engines, and for a time there was a flutter of excitement among railway engineers as to what would be the best means to adopt for arresting the emission of sparks and cinders, and thus protecting themselves as far as possible against the likelihood of claims for damage by fire raising. The result of this was that numerous spark arresters of one kind or another were rushed into the market; but like many that had come before, as well as some that have come since, most of them had to be discarded, either on account of the expense of fitting, but principally on account of inefficiency.

One defect which was common to most of the arresters, and which it is to be feared must attach to all of them in greater or less degree, at least where the arresting is done at the smoke-box end of the boiler, was that the more effective the apparatus proved to be as a spark arrester, the more dense was the volume of smoke emitted, and the more the free steaming of the boiler was impeded. Now, smoke in dense volume from the chimneys of our locomotives, in passing through residential districts, is regarded as a very objectionable thing; but it is more, and the railway companies are consulting their own interests in trying to mitigate the nuisance. Much black smoke clearly indicates imperfect combustion and a consequent waste of coal, and from a point of economy, therefore, it should be the endeavor of our engineers to steer clear of everything that tends in any way to baffle the exhaust steam at the chimney. The free steaming of the boiler, too, is adversely affected by this baffling process; because, instead of the bright flame passing through the tubes for a greater part of their length we have the black smoke referred to, which, instead of giving off the strong heat that the bright flame does, rather tends to leave a coating of soot on the inside of the tube, with the inevitable result that as the trip proceeds the steaming gradually becomes more impaired, and the stoker in consequence has to resort to the frequent use of the dart or poker, an expedient which is always attended with a further waste of fuel.

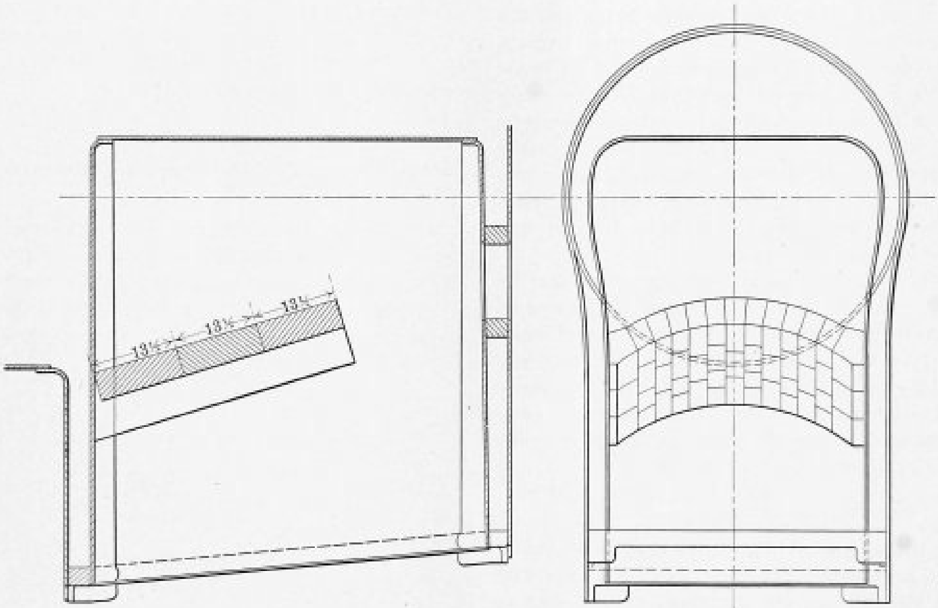


FIG. 1.—VIEW SHOWING A LONG BRICK ARCH WHICH IS CONDUCIVE TO GOOD COMBUSTION AND THE PREVENTION OF SPARKS.

It is the firm conviction of those on the foot plate that much less would be heard about the emission of sparks from the chimney if a longer brick arch in the fire-box were in more general use, and of this I think there is absolutely no doubt whatever. The tendency on the part of some boiler makers, in recent times, however, has been to shorten this arch considerably, and I will endeavor to show that, not only in the matter of spark arresting, but in the general efficiency of the boiler as well, the change is by no means justified.

Of course the idea is that by shortening the arch, and at the same time raising it at the back, the advantages gained are twofold. It is claimed, on the one hand, that with the long arch the action of the exhaust steam upon the fire has a tendency to cause the flame to strike too hard upon the back plate of the fire-box, damaging this part out of all proportion to the wear of the rest of it, and on the other hand it is claimed that, by the raising of the arch at the back, the tube plate is the better protected from currents of cold air getting in at the fire-door in the operation of firing, or when the fire is being cleaned.

Now, the shortening of the arch permits of a more direct pull upon the fire by the exhaust steam, and the obvious result of this is that cinders in greater quantity are drawn through the tubes and thrown from the chimney, some of them in such a live state that plantations and agricultural crops at certain seasons of the year could hardly escape being set on fire. Then the raising of the arch at the back allows of a greater accumulation of ashes on the top, the result of which is that the lower boiler tubes have a tendency to get choked up more readily, thus depriving the boiler of a considerable amount of heating surface; unless the arch has been so constructed that one or two small holes have been left close to the tube plate, when, instead of the ashes accumulating on the top, they simply fall down through these holes on to the fire again. This arrangement is in use on some railways irrespective of the style of arch, but it is open to some objection on account of the flame getting up through the holes and licking the ends of the tubes, and on account also of the imperfect combustion set up. There is, of course, the susceptibility of the tubes to leaking as a result of currents of cold air getting in at the fire-door; but this can only be in so far as the boiler falls into the hands of less careful enginemen, and as it is very well known that incalculable damage may be caused in this way, it can only take place through sheer disregard on the part of those in charge, and surely the better remedy would be to deal with the defects rather than try to circumvent his carelessness by introducing an arrangement of much less efficiency.

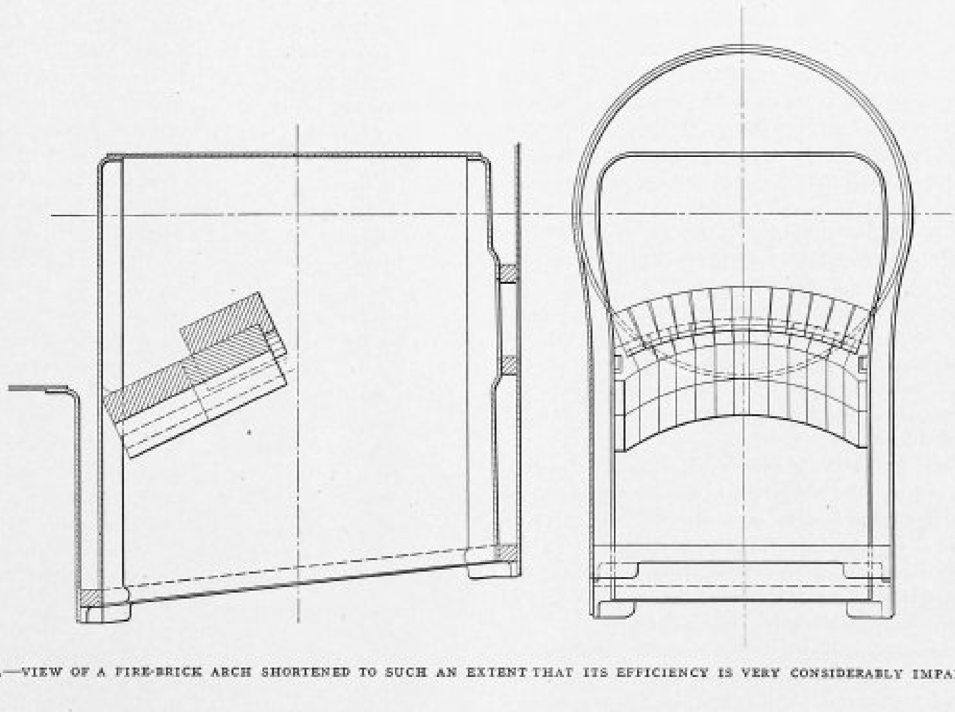


FIG. 2.—VIEW OF A FIRE-BRICK ARCH SHORTENED TO SUCH AN EXTENT THAT ITS EFFICIENCY IS VERY CONSIDERABLY IMPAIRED.

Regarding the question of premature wasting of the back plate of the fire-box, as a result of using the larger arch, I have never seen any reliable evidence in support of the statement, and I do not think, therefore, that the wasting can be so marked as to demand very much consideration. But even if it were, I venture to say that the saving in fuel that would accrue from the using of this arch is such as would amply compensate for any premature wear that might take place, not only in the back plate but also in any other part of the fire-box, and in addition to this we should have the enhanced efficiency of the boiler.

That the short arch is less efficient than the longer one was proved very conclusively by a short trial carried out on a British railway a short ime ago. Circumstances did not permit of such an exended trial as was to be desired, but nevertheless it was clearly shown that, compared with an arch 27 inches long, a saving of 5.32 pounds of coal per train mile was effected by one 9 inches longer; and not only so, but the steaming of the boiler was very much improved, and there was also a marked diminution in the sparks thrown from the chimney. What the result would have been had a still longer arch been tried it is, of course, impossible to say, as the trial had to be brought to a close rather abruptly; but I have no doubt at all that the limit of efficiency had not been reached when the test was completed, and that a still greater saving would have been effected had several inches more been added to the length.

These then are some observations from the point of view of the man concerned in the actual working of the locomotive boiler, and, although the subject may be regarded by some as a mere matter of detail, still there are no doubt many who would consider it of sufficient importance to justify further trials being made. The boiler maker may be opposed to anything that would tend in any way to shorten the life of the fire-box, and thus put up the cost of working his department; that is, assuming him to be in a position to make out a case against the longer brick arch; but there have to be put against this the much less risk of fire raising by the emission of sparks from the chimney; the much improved combustion in the fire-box, and the consequent improvement in steaming and reduction of smoke; and, what is of very much greater importance in these days of economy, an actual saving of fuel. The setting fire to a plantation may land the railway company in having to pay as much as might renew several fire-boxes. The reduction in the bill would soon mount up to be as much as would renew the boiler. There would be much greater freedom in the working of trains, and, on the whole, therefore, I think the matter is certainly worthy of something more than a passing consideration.

A joint meeting of the American Society of Mechanical Engineers and the Institution of Mechanical Engineers of Great Britain will be held at Birmingham, England, July 26 to 29. Plans are being made for the members of the society to sail together from New York on July 16, on the White Star liner *Celtic*.

IMPROVING PRODUCTION CONDITIONS IN A MODERN BOILER SHOP.*

BY H. S. KNOWLTON.

One of the most encouraging features of the work of improving the operating economy of industrial plants is the frequent possibility of reducing sources of waste by the expenditure of very small sums of money. This is particularly the case in the majority of new and well-designed plants, where, in the early years of service, there is ordinarily little occasion for extensive remodeling of the installation as a whole. In shops concerned with rapidly growing industries the individual tools are likely to undergo more or less change as commercial service continues, but if a plant is well laid out initially, the widest field for improvement usually lies in the direction of arranging the minor features of the installation to advantage—in taking up industrial lost motion, as it were, by the institution of a more perfect organization of men and materials, and by cutting down the waste of time at various points which were overlooked in the stress of starting the factory. Manufacturers are rapidly appreciating the importance of saving the greatest possible amount of time per job consistent with good work; they are becoming keenly alive to the cost of losing small amounts of material and supplies per day, multiplied into an impressive yearly total which is indisputably worth saving; and they are no longer slow to realize that sources of congestion and delay formerly accepted as necessary parts of the business become intolerable when subjected to the critical standards of modern practice.

Three years ago a new boiler shop was completed in a manufacturing city of the Eastern States, and was placed in service with the most modern equipment on the market. Many of the tools were electrically driven; compressed air was installed throughout the plant; liberal provision was made for the handling of material from the laying-out division to the shipping yard; and a first-class cost-stores system was inaugurated. Recently the plant was revisited for the purpose of comparing the establishment of to-day with that of 1906. Numerous improvements were in evidence, although the general design of the shop was unchanged, the arrangement of the tools was practically as before, and not a single machine of high power had been added to the shop's equipment. The improvements were not of a striking character as a whole, but in relation to increased economy of production or saving in time and labor they were thoroughly representative.

Handling the company's product between the testing bay and the shipping yard was much improved by the installation of a 50-horsepower hoisting engine equipped with double drums. Formerly all the product of the shops was hauled outside by a steam locomotive owned by the connecting railroad company. The cost of this service was so great that work had to be allowed to accumulate inside the shops, so that a number of boilers or tanks could be handled in a single working period, in order to reduce the cost of handling per boiler. The tendency toward congestion, just beyond the testing bay, became troublesome, and the desirability of being able to move the product at the moment of its completion from the painting division to the storage yard became too great for inattention. The installation of the hoisting engine enabled the company to handle from one to a dozen flat cars at its own convenience, the attendance being limited to that of its own employees, and the services of the railroad company's shifting locomotive were required only when movements between the shops and the outer limits of the yard were necessary. With the hoisting engine and a 50-ton yard derrick installed when the shops were built, boilers are now quickly placed either on the track for immediate shipment or transferred to a stock yard for temporary storage. The interior of the shop building is free from congestion.

Another improvement in the handling of material was effected by establishing a casting yard within easy reach of the tracks leading to the main line of the railroad passing the plant. Formerly the various raw and machined castings were stored at scattered points throughout the shops, occupying valuable space in the vicinity of the machine tools, more or less imperfectly classified and requiring considerable time in selection. In the casting yard, as now arranged, one side is set apart for the reception and weighing of the unfinished parts prior to machining, the other side containing completed castings in orderly groups ready for immediate transfer to outgoing trains. Assembly on the cars is accomplished with minimum loss of time and without sacrifice of valuable space, interference with production speed, or the selection of the wrong initial or spare parts through unsystematic storage methods.

In the original plant, water used in testing the boilers under hydrostatic pressure was purchased from the municipality and thrown away after use. The high cost of the water supply justified the construction by the company in its own shops of a 7,000-gallon tank and pipe system by which the water could be used repeatedly, only the leakage and other wastes of the testing bay being made up by the town supply. The new tank was placed below ground to avoid freezing, and connected with the hydrostatic-pump equipment in the boiler room; it has proved to be a decided economy over the former plan of using the test water but once. In connection with the testing of the boilers a telephone line was installed between the testing bay and the fire-room, and the control of the pressure at the product greatly facilitated. Instead of trying to vary the pressures by personal trips to and from the fire-room or by a system of bell signals, the test operator instructs the fireman without leaving the testing rack, and time, water and steam are saved by the immediate response to directions given over the wire. One of the most valuable improvements effected in connection with the testing of the product consists of the simple expedient of attaching an adjustable spring valve and drain pipe to the hydrostatic-pressure supply line running from the boiler room to the testing bay. Just beyond the hydrostatic pump, which supplies the water, a tap to a spring valve is taken off the main line, the discharge side of the valve being connected to a suitable sump. Upon receiving instructions as to the desired test pressure to be maintained, the fireman starts the hydrostatic pump, speeding it up to a point slightly above the limit desired at the testing bay, as shown by an attached gage. The spring valve is then opened slightly, by-passing enough water to the atmosphere to cause the pressure to fall to the desired amount, and the pressure is then automatically maintained as long as the pump speed is kept at the right point or above the normal by a few percent. The fireman returns to his regular duty of maintaining normal steam pressure at the boilers, and as long as that pressure is kept constant the pump supplying the testing rack works uniformly. If the pump speeds up slightly, tending to raise the pressure above the setting of the relief valve, the spring of the latter yields sufficiently to permit the discharge of a small quantity of water from the test supply line into the sump, at atmospheric pressure. Thus the pressure on the boiler under test remains steady so long as the steam pressure in the boiler room holds good; the fireman simply attends to his regular duties, and an extra man is not required to handle the pump.

On account of the poor quality of the boiler feed water at the plant it became necessary to introduce a compound just beyond the feed pump. This has been accomplished by installing a small horizontal pump cylinder, ½ inch in diameter by 2 inches stroke, on the side of the main pump cylinder, and driving it by a hinged lever attached to the rocker arm. A suction pipe ½ inch in diameter was run from the small

* From *The Engineering Magazine*.

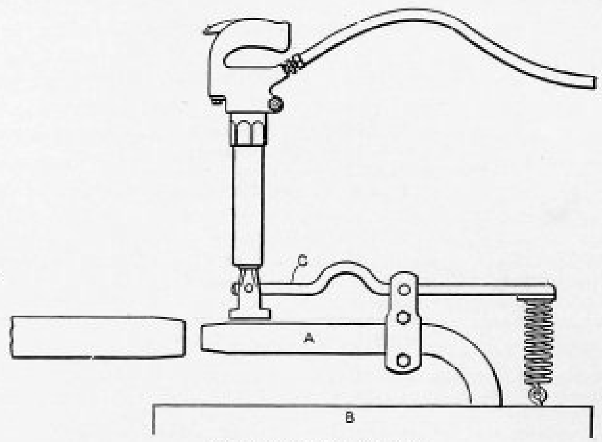
cylinder into a tank of boiler compound, and a discharge line of the same size connected with the boiler feed pipe. By attaching the hinged lever to the rocker arm the compound is regularly pumped into the feed line, and as the flow of compound corresponds with the speed of the feed pump, the proportion of compound applied remains correct, the device operating automatically without the necessity of attendance.

A short time after the shops were started it was found that much valuable time was lost in the collection of small material used in boiler making, and more systematic methods of storing rivets, bolts, plates, punchings and fittings were sought. Bins were therefore set apart with marked compartments showing the character and size of each part on hand, and in order to facilitate the taking of the annual inventory, the capacity of each bin was translated into weights. The weight of rivets in a full compartment was determined, for example, so that by measuring the height of the material left in the bin at any time the weight on hand could be immediately ascertained. The company adopted the plan of stamping the ends of its boiler plates with the dimensions and quality of each piece, which saved the time required to measure the plates in their selection for the production of each boiler or tank. Thus, a plate of fire-box steel marked "171 × 92⅞ × 11/32 F B S," could be picked out easily from odd sizes, avoiding the inconvenience of measuring it in the rack and the possible use of the supply department crane before it could be fitted to the work in hand.

The accumulation of heavy punchings, light iron and larger pieces of scrap was not well handled at the time the shops were opened for service, and recently the company built a tank for the reception of these rougher and bulkier materials, making the box 16 feet long, 4 feet wide and 5 feet deep, with a sliding door at one end and suitable lugs on the sides and door. By the use of the lugs the scrap tank can be handled with the utmost facility by the shop crane, and the entire contents dumped into a gondola car at minimum expense for handling. Two other labor-saving devices were installed in connection with the handling of tool compound. One was a small tank underneath the tube drills, which was piped to a small belt-driven pump mounted on the machine frame, the pump being operated by the movement of the shafting driving the drills. The compound is now used repeatedly with little waste, being pumped from the receiving tank to the distributing pipe system while the machine is in service. The second improvement consisted of two compound tanks placed 8 feet above the floor, and piped to a screened basin below which the supply pails for the various machine tools are filled. The distributing lines from the tanks were valved, so that the strength of the compound can be set at any desired point, and much time is saved by this centralization of one of the important auxiliary processes of the plant. Finally, an air whistle was installed at the tool-room distributing window to save waiting for the stockkeeper to observe that a workman desires a tool. Another improvement along the same line was the installation of a bell alarm signal on the telephone of the pattern shop. Plans are now under way to remove the paint and oil-storage department of the plant from the vicinity of the pattern shop, the latter being practically the only department with combustible material stored within its precincts.

Pneumatic Flue Welder.

An inexpensive flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel *A*, which is attached to a cast-iron Block *B*, and a pneumatic hammer (equipped with a swage), which is mounted on a lever *C*. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about 6 inches below the level of the mandrel. This gave a taper of approximately ¼ inch to the inch. After all the long pieces were scarfed, short pieces about 8 inches long were placed in the furnace and heated



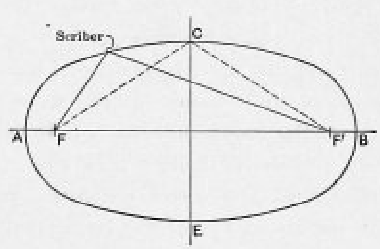
PNEUMATIC FLUE WELDER.

on one end, so that they could be drawn to a feather edge. This was also done under the pneumatic hammer. After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot, so they would shrink tightly in place, thus insuring a good, clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with.—T. O. Martin in *Machinery*.

Jackson, Tenn.

How to Draw an Elliptical Manhole.

Draw the major and minor axes *AB* and *CE* at right angles to each other and bisecting each other. With a radius equal to one-half the major axis, mark off from *C* or *E* the foci points *F* and *F'*. At each of these points fix a small nail



METHOD OF DRAWING AN ELLIPSE.

and loop a cord upon them equal in length to the axis *AB*, so that when stretched it will reach to the extremity *C* of the minor axis. Place a scriber inside the loop, and guiding the scriber by means of the loop, keeping the cord taut, draw the ellipse.

SUBSCRIBER.

New specifications for steel boiler tubes have been issued by the Pennsylvania Railroad, which permit the use of cold and hot-drawn and lap-welded tubes. The chemical requirements simply limit the percentage of phosphorus and sulphur. For the latter .04 percent is made the upper limit.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Inspection of Locomotive Boilers.

Every few months someone who is not particularly well informed regarding the conditions under which locomotive boilers are operated brings forward a statement to show that, due to lack of Federal inspection, locomotive boilers are continually being operated in an unsafe condition, and the number of explosions which occur is cited to support the contention that legislation should be enacted regulating the construction and inspection of all locomotive boilers owned and operated by railroads in the United States. Whenever such statements have been made we have not hesitated to contradict them, and assert that there is no class of boilers in operation which are so carefully looked after or so wisely operated as locomotives on the steam railroads. It is estimated that there are more locomotive boilers than any other type in operation in the United States, recent statistics showing about 60,000 in active operation. Out of this large number of boilers during the months of April, May, June, July and August of last year, only nine explosions occurred, according to the statistics published by *The Locomotive,* the official organ of the Hartford Steam Boiler Inspection & Insurance Company. During that period there were 159 accidents that were classed as boiler explosions. From this it is evident that both in proportion to the total number of explosions of boilers and in proportion to the total number of locomotive boilers in operation the percentage of explosions of locomotive boilers is exceedingly low, and it is doubtful if any Federal legislation regulating the construction and inspection of these boilers would reduce this figure.

What Government inspection of locomotive boilers might accomplish is shown by the annual report of the inspector of locomotive boilers of the New York Public Service Commission, Second District. For the last two years all locomotive boilers operated in the State of New York have been under the supervision of the State boiler inspector, and the results of this system are now well defined. The chief inspector comes to the conclusion that the systematic checking of the railroad companies' inspectors and inspection systems will, if properly carried out, give good results and be a decided benefit, but that the appointment by the Government of detailed boiler inspectors to duplicate or supersede the inspection work now carried on by the railroads would have the disadvantage of relieving the railroad companies of at least a portion of the responsibility which properly belongs to them, and in addition would be vastly more expensive than the present system.

The greatest value, then, of Government inspection of locomotive boilers appears to be the improvement of the inspection service carried out by the railroad companies themselves. Such supervision undoubtedly would bring many points to the attention of railroad companies which now are being neglected or slighted. For instance, since Government inspection has prevailed in New York, particular attention has been paid to the water glasses, gage cocks and injectors, with the result that accidents due to low water have been materially reduced. Undoubtedly many more similar benefits would arise if State or Federal inspection prevailed throughout the country, and such a system might help very materially to bring about uniformity and standardization in boiler construction. These, we believe, would be the direct benefits of Government inspection of locomotive boilers rather than any remarkable decrease in the comparatively few explosions which now occur. If Federal legislation is to be extended to cover any boilers it should, first of all, be applied to stationary boilers, where such havoc is wrought through ignorance, neglect and carelessness.

Economic Production.

Although the economic production of the output of any boiler shop is a matter which concerns superintendents and managers more vitally than it does the boiler maker, who is actually doing the work, yet it should not be lost sight of by the latter. Conditions are seldom so good in any shop that there is no room for improvement, and it is usually the workman himself who has the first chance to see the need of a change, and can suggest the most advantageous way of making it. In spite of this, many men go about their work apparently with their eyes closed, taking it for granted that the foreman sees everything that they do, and that, consequently, it would be useless for them to suggest anything. As a matter of fact, the foreman usually has so many matters to occupy his attention that he cannot always get down to consider carefully many small details which would affect the economic production of the shop. This is the boiler maker's opportunity, and one which he should seize whenever it is offered; for once a man gets the reputation of being a keen observer and of having good judgment, his promotion is sure to be rapid.

BOILER MAKERS' CONVENTION.

Fourth Annual Convention of the International Master Boiler Makers' Association, to be Held at the Clifton Hotel, Niagara Falls, Ontario, Canada, May 24, 25, 26 and 27.

After some months of uncertainty it has finally been decided to hold the fourth annual convention of the International Master Boiler Makers' Association at Niagara Falls, Ontario, Can., on May 24, 25, 26 and 27. The headquarters of the association will be at the "Clifton Hotel," where unusual advantages will be offered for the display of machinery, tools and other boiler shop equipment. The location affords many places of interest for sightseers and travelers to visit, and an elaborate programme of entertainment is being provided by the Supply Men's Association.

The programme for the meetings of the association includes reports on the following topics:

Standardization of Blue Prints for Building Boilers.

Best Method of Applying Flues.

Best Method of Caring for Flues while Engines are on the Road and at Terminals, and Best Tools for Same.

Flexible Stay-Bolts Compared with Rigid Bolts; Best Method of Applying and Testing Same.

Steel vs. Iron Tubes; what Advantages and what Success in Welding.

Cause of Flue Holes in Back Flue Sheet Elongating and Preventive Measures for Same.

Standardizing of Shop Tools.

Standardizing of Pipe Flanges for Boilers and Templates for Drilling Same.

What Radical Departures are Being Made in Boilers and Fire-Boxes?

To what Extent do Fire-Box Holes Crack and what is Being Done to Prevent Same?

Best Method of Staying the Front Portion of the Crown Sheet on Radial-Top Boilers to Prevent Cracking of Flue Sheet in the Top Flange.

COMMUNICATIONS.

Leaky Tubes.

EDITOR THE BOILER MAKER:

I have received a letter from the W. H. Wood Fire Box & Tube Plate Company, of Media, Pa., referring to an article which appeared in *The Railway Age* of Nov. 5, 1909, entitled "The Cause of Leaky Tubes." I am inclined to agree with Mr. Wood that it is not proper to lay all the blame on the poor, hard-working boiler maker. They generally earn all they get and should have more credit for what they do, as it would make them try to do better. Sometimes the boiler maker gets a set of tubes to put in; the foreman will very likely, without thinking, take the size of tube holes for copper, say a 35-pound copper will do. The hard enamel is not rolled out of the holes yet; the boiler maker rolls this out when he gets the coppers, the hole is larger, and he will have to jump the copper to make it fit. Then he may not roll them hard enough. If coppers are not rolled tight enough the tubes leak the first or second trip, and cause the copper to oxidize the metal which forms the hard enamel. After this enamel collects it is very hard to keep the tubes tight; for when they are worked with the expander this breaks out, leaving pinhole leaks all the time. A great many times we notice that the tubes leak in the center and not in the two outside rows. From my experience, I think that this indicates that the bridges are too narrow, and will not allow the proper volume of water to circulate around the tubes according to the units of heat that are forced through them.

One locomotive running on the Southern Pacific out of Los Angeles with her first set of tubes, hardly ever made a trip without the tubes leaking. I was running the flange fire at the time, and made a note of it. When this engine came in for a fire-box, I found that she needed a front tube sheet. In laying out the tube holes I left out two rows of tubes, which gave me a 13/16-inch bridge. I asked permission to put in the tubes myself when this engine went into service again. There were no more leaky-tube reports for a while, although the same engineer ran her on the same run.

In '83 I was foreman on this road, and we had engines that would stay tight on the east end, but when we changed them over to the west end, if they took water at Gita Bend, we would have to work all the tubes, and sometimes the engine would die before getting back. One in particular leaked on the bottom near the left side all the time. I told the master mechanic that there was mud baked solid around these tubes, which, by overheating, caused unequal expansion and contraction, and I told him that they would not last many days more. He said that the engine must be kept in service. It ran five days longer, when one tube burst coming up the hill into Red Rock. At that time we had a piece of 1-inch gas pipe with three steel springs to hold the plug, and a 7/8-inch ramrod to drive in the plug. The engineer got down to ram in the plug when thirty-seven other tubes collapsed, scalding his arms badly. They hauled the engine in dead. I had a boiler maker get out the bad tubes; we had to disconnect the steam pipes and take out nigger head and dry pipe. We also had to disconnect six rows of tubes in the center in order to cut the hard-baked mud away, so as to transfer the tubes out of the dry pipe hole. Thirty-five of these thirty-seven tubes were collapsed as flat as any steam hammer could flatten them. For a space 3 feet long they started 4 inches ahead of the feed-water discharge on the fireman's side, 32 inches back. Only two burst, which proves that unequal temperatures caused these to leak. The jar caused them to collapse, getting water on them when they were so hot.

I note that Mr. Wood writes in regard to having a tube sheet and furnace that will take up its own expansion and contraction. If he will call at the Baldwin Locomotive Works, he will see the Jacob-Shupert corrugated flanged fire-box, which is made in sections, the fire-box flanges being riveted in the water space with a calking sheet run next to the fireside even with the heel of the flange. It also thus forms a wing stay sheet with slotted holes, for circulation, extending to the outside shell flanges and riveted outside. It is the most logical proposition I have ever seen. It takes up the contraction and expansion in each section, the metal being of uniform thickness in fire-box, the circulation is so swift that it keeps the sheets clean on the crown.

I have noted many times that an engine will make a round trip and do excellent work and never leak a drop; but when a rush order comes to get them ready for service again after they get into the round-house; the fire-door is opened up; steam blown off and cold water put on top of 60 pounds of steam through the injector; and then they will leak badly, sometimes making nearly every tube leak. I have taken the same engine, without allowing them to put a drop of water in to cool it down until the steam is all blown off, and by keeping cold air out of the fire-box entirely prevented leakage.

In the Jacob-Shupert corrugated flanged fire-box there are no stay-bolts to break. The tube sheet can give either way. I have been making a comparative list lately for the Santa Fe Railway, and find that the engine that has the Jacob-Shupert fire-box in it has no boiler work to speak of, and only averages

$5 on tubes per month. It also does better on fuel than any of the other engines. This engine has tubes 17 feet long, with a dome centrally located and carries water in the water-glass. I have noted that on a trip of 100 miles' continuous run with 1,064 tons, the steam did not vary 5 pounds or the water 1 inch. This engine was a tandem compound. It was tested against another engine that had tubes 20 feet long, and which I know did not carry water nor steam as well. With 20 and 21-foot tubes the former engine, with a dome within 3 feet of the front tube sheet, sometimes pulls water up in glass 10 inches. I believe in giving them more fire-box heating surface, in burning oil, and using tubes not over 17 feet long, for when these long engines are going over the heavy grades the elevation shows that the body of water way up in front is too light to work on and can be lifted when working hard, which may leave the front portion of the tubes bare long enough to cause unequal expansion and sudden contraction when the water returns, causing the tubes to leak badly.

JOE HOLLOWAY, Inspector.

Needles, Cal.

Layout of a Transition Piece.

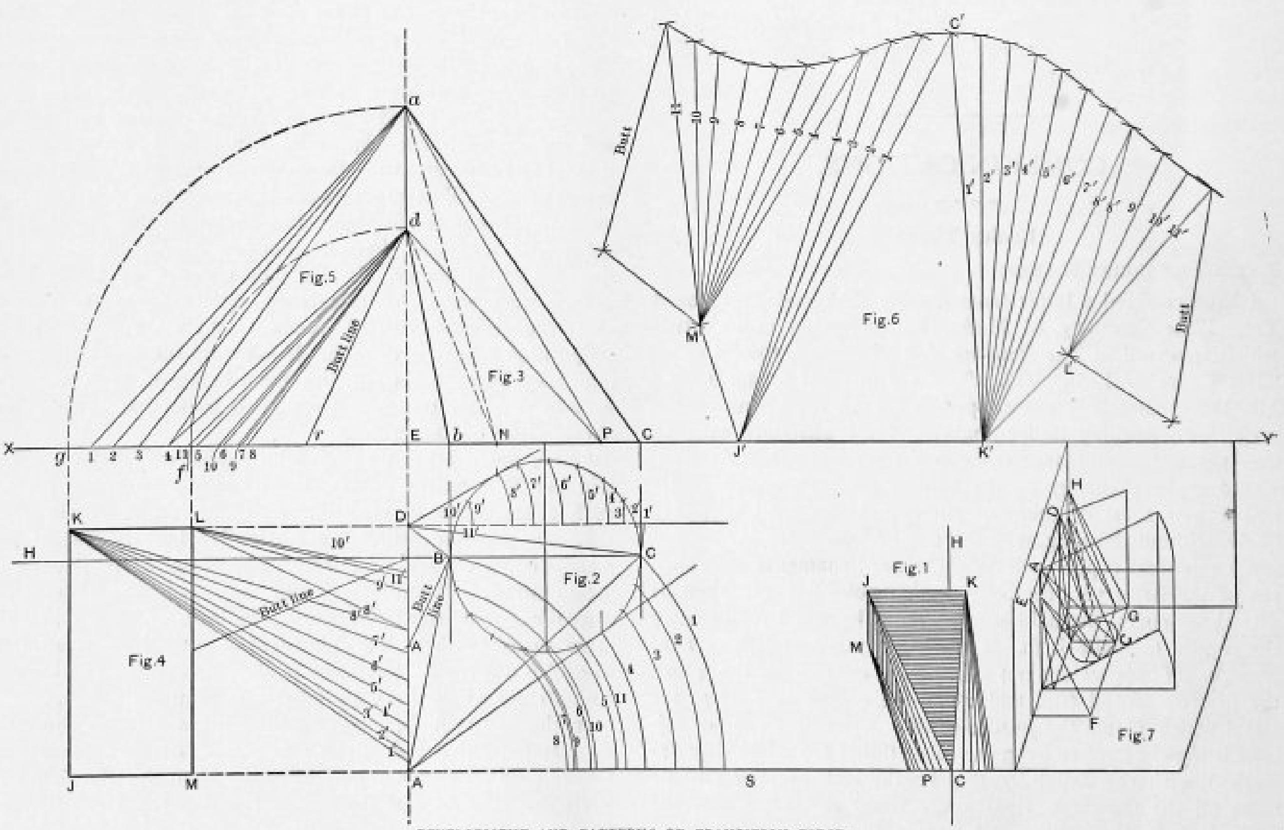
EDITOR THE BOILER MAKER:

Fig 1 shows how the job would appear if viewed along the line *X Y*. Attention is directed particularly to the following point regarding the flat triangular surfaces, viz.: that they are not equidistant around the circle as some would expect (that is, where the use of tangent planes comes in, as it shows each line to be a generating line, or a straight line lying in a plane that has been moved around so that the plan touches the top and bottom of the rectangle, also the circle, making the traces two straight lines forming each particular triangle. I have purposely put the rectangular hole at some distance to one side, to demonstrate the particular use of these tangent planes). The traces that form the flat triangles are all shown in the drawing, Fig. 7, which represents three planes, such as the two adjoining walls and floor of a room.

Draw the lines *X Y* and *A a*. Draw the elevation as *a, d, b, c*, Fig. 3, also draw the circle *B, C*. Fig. 2 (this being the plan of *b c*), at any convenient distance below the ground line *X Y*, and produce *B C* well towards *H, C H* being parallel to *X Y*. Then from *E*, with *E d* and *E a* as radii, draw the quadrants *d f* and *a g*. From *g* and *f* draw lines parallel to *E A*, and cut them off so as to form the rectangle *J K L M*, Fig. 4. Also in the respective positions required, as from the line *H C*, produce *K L* and *J M* well beyond the line *E A*, but cutting the line *E A* at *D* and *A*. From *D* and *A* draw tangents to the circle, as shown in 8' and 4, Fig. 2. Then if these two points of contact were projected to the line *X Y*, we would have the points *N* and *P*, Fig. 3, and if these were connected to *d* and *a*, as shown, we would have the elevation of two of the four flat triangles. The plans of the other two are shown in *D B A* and *D C A*, Fig. 2, their elevations being *d b* and *a c*.

Divide the circle, Fig. 2, into any number of parts, not necessarily equal, then from *A*, with radii *A* 1, *A* 2, *A* 3, etc., draw the arcs as shown. Transfer all the points obtained from the line *A S* to the ground line *X Y* from *E*, as 8, 7, 9, 6, etc., and connect the points 1, 2, 3, 4 to the point *a* for their true lengths, also the other points as shown. Then from *D* obtain all the other points as 10', 11', 9', 8', etc., and transfer them to the line *D A* from *D*, and connect to *K L*, as shown, for their true lengths. From *E*, with radius *B R*, cut the line *X Y* in *r*, and connect to *d* for the true length of the butt line. Of course, the butt may be put in any other position if required.

To lay out the development from any point *J'*, Fig. 6, with radius *J K*, Fig. 4, cut the line *X Y* in *K'*, then from *J'* and *K'*, with radii 1 *a*, Fig. 5, and 1' *K*, Fig. 4, respectively, draw the arcs intersecting in *C'*. Connect *C' J'* and *C' K'*. This will form the large triangle as shown in Fig. 1, the plan of which is shown *D C A*, Fig. 2. This triangle is shown at *D C A*, Fig. 7, lying in the plane *E F G H*. Now, from *J'*, Fig. 6, with



DEVELOPMENT AND PATTERNS OF TRANSITION PIECE.

radii a 2, a 3 and a 4, Fig. 5, draw arcs as shown, and from K', Fig. 6, with radii 2′ K, 3′ K, 4′ K, etc., to 8′ K, Fig. 4, draw arcs as shown. Now, instead of using dividers to cut these arcs, a thin lath should be bent around the circle, Fig. 2, and all the points marked on the lath, then put the point C on the lath to the point C' in Fig. 6, and bend the lath to a fair curve, so that all the points lie on their respective curves that were drawn from J' and K' as centers. This will give us a fair curve as C' to 4 on one side and C' to 8′ on the other side. Connect J' 4 and K' 8′. Now, with 4, Fig. 6, as a center and radius d 4, Fig. 5, draw the arc M', then with J' as a center, and J M, Fig. 4, as radius, cut the arc in M', connect J' M' and M', thus forming another triangle. Obtain all the other points so that a fair curve may be drawn through them, in a similar manner to what has been shown. Now, if lines be drawn from J', K', M', L', as shown, they will all be rolling or bending lines, and will be straight lines at all times.

Although this development is made up of triangles, it must be understood that it is not triangulation, as implied by my letter in the December, 1909, issue.

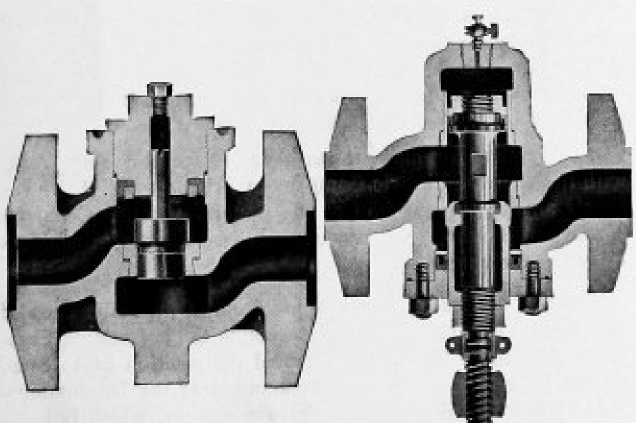
Cardiff, Wales. I. J. Haddon.

ENGINEERING SPECIALTIES.

Special Hydraulic Valves.

The special types of hydraulic stop valve and check valve which we illustrate have recently been installed in one of the plants of the New York Edison Company, and are illustrative of the Edison Company's efforts to provide every possible protection against shut-downs.

Over a hundred of these valves, in 2-inch, 2½-inch and 4-inch sizes are installed on the forced-feed lubricating system, which serves the step bearings of the Curtis turbines. This lubricating system is under 1,500 pounds per square inch pressure, is provided with accumulators to deliver pressure in case of the temporary failure or stopping of the pumps, and



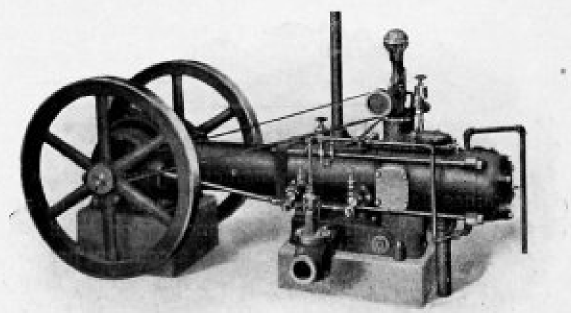
all joints in the lines are welded to prevent failure. All parts are three or four times as heavy as ordinarily, and the bodies of the valves are made of steel and extra heavy. Strength, however, was not the main question in discarding other valves on this service. It was found that ordinary rubber, hemp or leather packing would not stand up with oil and the unusually heavy pressure, but was subject to annoying blowouts. These troubles were overcome in the Watson-Stillman stop valve in two ways: First, by using a special packing, which would not soften, but would retain its elasticity; and second, by a construction which would permit the system to be used, even though a packing weakened. The improvement in the latter instance consists in the addition of the small pressure-tight chamber under the end of the valve stem. When running under ordinary conditions the small pet cock at the bottom is left open to act as tell-tale if a packing starts to leak. Should the packing leak, the pet cock is closed and the valve used until such a time as a repair may be conveniently made.

Both stop and check valves have seats of a special metal, which is spun into place. The check valve stem is slotted, so that by removing the screw on top of the valve a screw-driver may be used to regrind the valve seat.

These valves were made by the Watson-Stillman Company of New York.

The Chicago High-Speed Air Compressor, Type H.

Air compressors as ordinarily constructed are limited to moderate running speeds. This is chiefly due to three features of construction, viz.: unsuitable air valves, restricted air passages and inadequate water jacketing. By giving special attention to these features, the Chicago Pneumatic Tool Company, Chicago, Ill., has developed an air compressor which, it is claimed, will permit a much higher speed and effect a considerable increase in efficiency and eliminate the objectionable noise which are usually features of air compressors running at moderate speeds. The advantages of any



high-speed compressor are, briefly, reduced first cost, decreased floor space and less expensive foundation. It is also claimed that an efficient air compressor, running at a high speed, will yield a much greater output of compressed air than is given by a slower running, less efficient compressor of equal weight and size. It is claimed that the Chicago compressor herewith illustrated delivers from 60 to 90 percent greater volume of compressed air than is delivered by ordinary compressors of equal cylinder volume.

The method of oiling the running parts of an air compressor is one of the most important considerations of its design. The oiling system of the Chicago high-speed compressor provides for a large reserve supply of oil, which will remain clean and retain its lubricating qualities as long as will the oil used in the self-oiling bearings of a high-grade electric motor or generator. The working parts are completely inclosed, and as no pipes are used and the oil passages are liberal, it is almost impossible for them to become obstructed. Pins and bearings for the valve gear are lubricated by automatic grease caps of liberal capacity.

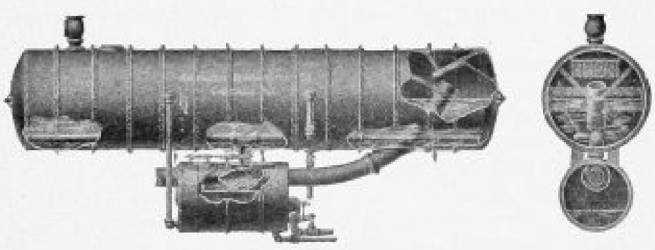
The mechanically operated inlet valves are designed to give liberal openings for the entering air and also to reduce clearance space to an unusual extent. This has been accomplished without resorting to the unsafe practice of allowing part of the valve to extend into the cylinder during a portion of its travel. The form of the discharge valve permits lightness without sacrifice of strength, thus insuring the minimum of valve resistance and noise of operation. Important also are the large free air spaces in both inlet and discharge chambers, and the exceptionally ample and unobstructed water jackets. These are features which make for high efficiency and permit high speed.

Cylinder-head joints are avoided by casting the cylinder head and half of the cylinder barrel in one piece; thus there is only a single joint and this is midway of the length of the cylinder, sustaining an air pressure of less than 15 pounds per square inch in single-stage compressors. It is claimed that this construction eliminates gasket troubles. The use of tie bars instead of cylinder-head bolts permits a simple gasket construction and permits of free and unobstructed circulation of jacket water. It also affords ready access to the piston. The main bearings, crank pin and crosshead pin are a generous size, and the bearing surface of the crosshead shoes is ample. The connecting rod is of forged steel, with a wedge adjustment at each end. The crank-shaft is a steel forging with rigid crank arms. The counterweights secured to these arms give effective counterbalancing, and with a large flywheel tend to eliminate vibration.

These compressors are built for belt, rope, chain or gear-drive, as well as for operation by steam or gas cylinder. The illustration shows the compressor equipped with a gas cylinder, using either gas or gasoline as fuel. This compressor is a complete independent power unit, and it is obvious that such a machine is well adapted for use where other sources of power are lacking, or for operating independently of the main power. It also fills the requirements of a portable compressor, since the fuel cost is low and expert attendance unnecessary.

The American Regenerator.

The use of reciprocating engines in combination with steam turbines has created a need for a new type of auxiliary apparatus. One of the requirements for good steam-turbine practice is, that there should be a constant pressure at the first stage of the turbine. When the turbine takes the exhaust steam direct from a reciprocating engine, the supply is always intermittent. Furthermore, the loads on the steam turbine and reciprocating engine can seldom be maintained exactly the same, consequently it happens that at one moment the reciprocating engine discharges a larger volume of steam



than the turbine can use, and at the next moment, an overload occurring on the turbine, there is not sufficient steam exhausted to meet the load. This condition of things has led to the development of some sort of steam storage arrangement which can absorb the excess exhaust steam one moment and carry it over to make up the deficiency the next.

The standard of perfection for such a storage arrangement, or regenerator, is that the temperature of the water (or other substance) in it shall respond to the entire range of temperature as the steam pressure within the apparatus rises and falls. In the American regenerator, manufactured by the American Regenerator Company of Chicago, each particle of steam entering the apparatus comes into intimate contact with many times its own weight of cold water.

As shown in the illustration, the water from the large tank falls through a pipe containing a valve into an annular space surrounding the perforated spray pipe, through which the exhaust steam from the engine enters at the left. In entering the lower chamber the exhaust steam turns a vane, which, in turn, controls a valve in the pipe connecting the upper and lower chambers; thus the amount of water supplied to the outside of the spray pipe is always proportional to the amount of exhaust steam passing through it. In this manner the steam comes into thorough contact with every particle of water, so that the water is heated up to the full temperature of the exhaust steam. The momentum of the steam is sufficient to carry the mixture of water and steam up through the eduction pipe into the upper tank, where the mixture is delivered against suitable baffles and separated from the steam.

Thus it will be seen that the coldest water in the regenerator is intimately mixed with the exhaust steam and returned to the surface of the water, giving, it is claimed, perfect circulation and perfect mixture of the water and steam. Also since the water level is at the center of the tank, there is left only a shallow depth of water, enabling steam to be readily disengaged during re-evaporation.

The operation of the apparatus is as follows: When the supply of steam from the engine is insufficient for the turbine, the turbine draws steam from the regenerator and the pressure therein falls. This leads to the re-evaporation of some of the water in the regenerator, the heat for this evaporation being supplied by the water which falls in temperature. On the other hand, if the engine delivers more steam than could be used by the turbine, the pressure and temperature rise, whereupon some of the steam gives up its heat to the water, causing condensation.

PERSONAL.

E. McNamara, formerly an inspector with the Hartford Steam Boiler Inspection & Insurance Company, with headquarters in Chicago, left this company on Jan. 1, and is taking up a four-year course in medicine and surgery at the Davenport Chiropractic College, Davenport, Ia.

R. E. Howe, foreman in charge of boiler and tank work, with the General Electric Company at Schenectady, N. Y., requests anyone writing him at the General Electric Company to put on Building No. 66, as otherwise he has great difficulty in receiving mail.

William T. Clemo, formerly layer-out at the boiler shop of the foundry department of the Anaconda Copper Mining Company, Anaconda, Mont., has accepted the position of foreman of the boiler and sheet steel department at the International Smelting & Refining Company's new smelter, which is being erected at Tooele, Utah, about 35 miles from Salt Lake City. This company has a well-equipped boiler shop and is doing much of the new work going into the erection of the smelter.

N. J. Fitzhenry has resigned his position with the Traylor Engineering Company, Allentown, Pa., and has accepted a position of foreman boiler maker for the Bethlehem Steel Company, New Castle, Pa.

James Doran has recently been made boiler inspector of the Western lines of the Sante Fe Railroad, with headquarters at La Junta, Col.

Andrew Hillhouse has recently been appointed master boiler maker of the Cincinnati, Hamilton & Dayton at Lima, Ohio.

H. C. Cunningham is now master boiler maker of the Atlanta, Birmingham & Atlantic at Fitzgerald, Ga.

FRED GRAEFE has resigned his position as master boiler maker of the Santa Fe, to accept a similar position with the El Paso & Southwestern at El Paso, Tex.

A. HEDBERG has recently been made master boiler maker at Winona, Minn. He was formerly master boiler maker at the Chicago & Western at Boone, Ia.

W. J. RITCHIE, chief boiler inspector of the Erie Railroad, and formerly master boiler maker of the Santa Fe at La Junta, Col., died recently in a hospital at Jersey City, N. J.

JOS. H. LOVICK, formerly master boiler maker of the Baltimore & Ohio at New Castle, Pa., died recently at his home.

F. A. HALL, who, for twenty years, has been manager of the chain block department of the Yale & Towne Manufacturing Company, New York, has resigned, to accept the position of vice-president of the Cameron Engineering Company, Brooklyn, N. Y. Mr. Hall became associated with the Yale & Towne Manufacturing Company over twenty years ago as a tool maker and draftsman, but was subsequently promoted to the position of engineer in charge of the design of light cranes and overhead track. He was afterwards made foreman in charge of the chain block shop and has recently introduced and managed the sale of the well-known triplex block. This experience makes Mr. Hall ably fitted to carry on the commercial development of the products of the Cameron Engineering Company, which controls a number of patents relating to the overhead transportation or conveying of work and material covering hangers, switches, turn tables and ball-bearing trolleys. Mr. Hall will be succeeded by R. T. Hodgkins, who for several years has been his assistant.

The Technical Literature Company, publishers of *The Engineering Digest,* announce the consolidation of *The Engineering Digest* with *Industrial Engineering.* The publication will be under the editorial management of Robert Thurston Kent, formerly managing editor of *Industrial Engineering.* It is the intention to continue the special features of *The Engineering Digest,* including the valuable index to current technical literature and the continuation of important articles and papers on engineering subjects. To this will be added special features along the lines of industrial engineering, and original articles on engineering subjects distinct from the civil and electrical engineering matters, which are so well taken care of by other periodicals.

SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

935,884. WATER-TUBE BOILER. JOHN E. BELL, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A water-tube boiler having at least two transverse steam and water drums connected by banks of tubes to a lower transverse mud drum or drums, a baffle between the two banks of tubes, a baffle in the rear of the second bank, and tubes adjacent to the rear baffle and connected to the circulation at their upper and lower ends. Ten claims.

936,412. STEAM-BOILER SUPERHEATER. FRANCIS J. COLE, OF SCHENECTADY, N. Y.

Claim 1.—In a steam boiler superheater, the combination of a superheater casing extending longitudinally adjacent to a steam boiler and communicating, at its opposite ends, with the fire-box and the smoke-box thereof, respectively, a steam header supported in the smoke-box, and superheater pipes located in the superheater casing and connected at their forward ends to the steam header. Eight claims.

937,898. STEAM-BOILER FURNACE. FRANK WAGNER, OF NEWPORT, KY., ASSIGNOR OF ONE-THIRD TO JOSEPH M. BETZ AND ONE-THIRD TO FRANK F. HAMMER, OF NEWPORT, KY.

Claim.—In a steam boiler furnace adapted to use gas as fuel, having fire brick floor and walls and divided by vertical walls making a series of combustion or fire chambers, each chamber having a vertical column placed behind an air opening in the floor, said vertical columns dividing the combustion particles in such a manner as to cause them to spread throughout the fire chamber, and a brick wall built with suitable openings for equalizing and retaining heat and placed behind said fire chambers. One claim.

937,967. SHAKER FOR GRATES. WILLIAM J. SIMPSON, OF KOOTENAI, IDAHO, ASSIGNOR OF ONE-HALF TO LEWIS W. HAMEL, OF KOOTENAI, IDAHO.

Claim 1.—The combination with a locomotive axle and shaking grate of a support extending across under the axle, a slide mounted on the support and operatively connected to the grate, a movable carrier mounted on the support, a wheel on the carrier, and arranged to be moved into or out of contact with the axle, a pitman connecting the wheel and the slide, and means to shift the carrier. Two claims.

938,022. STEAM-BOILER FURNACE. FRANK A. SHOEMAKER, OF BUFFALO, N. Y., ASSIGNOR TO JAMES STURDY, OF BUFFALO, N. Y., AND JOHN STURDY, OF CRAFTON, PA.

Claim 1.—A boiler furnace having a boiler, a combustion chamber, a rack of water tubes connected to the boiler, and a firing magazine separated by the rack from the combustion chamber, the passages through the rack between the water tubes being flaring and wider at the outlet end facing the combustion chamber than at the inlet end. Thirteen claims.

938,035. HORIZONTAL BOILER. EMIL A. BEYL, OF MINNEAPOLIS, MINN.

Claim.—In a horizontal boiler, the combination with a main cylindrical shell segmentally cut away on its under side and provided with segmental crown sheet and segmental flue sheet co-operating with each other and said shell to afford the upper end of the fire box, of the pair of concentric vertical cylinders spaced apart and connected water tight at their lower ends, and which cylinders have, on their upper ends, segmental joint flanges both riveted fast to said main shell of the boiler with the intervening portion of the main shell perforated to connect the water spaces of the main shell and the leg formed by the parts, a grate at the bottom of the cylinder and a fuel admission door at the top of the fire box. One claim.

938,036. FIRE-BOX. WILLIAM D. BOYCE, OF ST. LOUIS, MO.

Claim 2.—A fire-box having a side wall provided at the front end with openings discharging vertical sheets of air across the path of travel of the combustion products, and nozzles at the front corners of the fire-box for projecting horizontal sheets of steam across the air sheets and in a direction opposed to the general direction of flow of the combustion products. Four claims.

938,171. LOCOMOTIVE BOILER. SIDNEY A. REEVE, OF WORCESTER, MASS., ASSIGNOR TO CHARLES F. BROWN, TRUSTEE, OF READING, MASS.

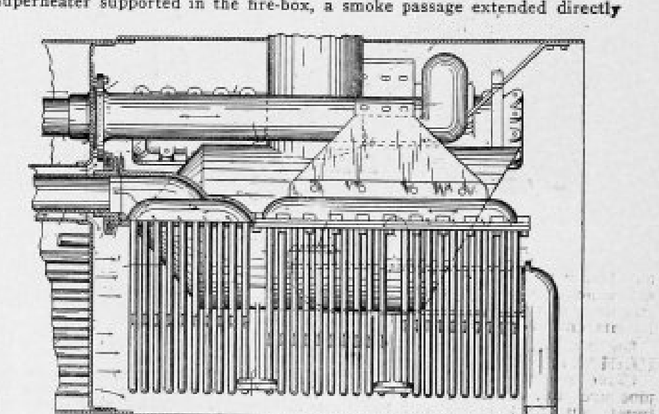
Claim 1.—A locomotive-type boiler having water-vaporizing, steam-superheating and water-preheating surfaces, heating flues adapted to conduct the gases over said surfaces successively in the order named and in forward and return directions, a stack at the rear part of the boiler adapted to discharge a portion of said gases before they have completed the entire passage of said heating surfaces, and a second stack at the forward part of the boiler adapted to discharge gases which have completed the entire passage. Seven claims.

938,449. SUPERHEATER BOILER. EDWARD H. WELLS, OF MONTCLAIR, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A superheater comprising a plurality of similar U-tubes each having its legs in a substantially vertical plane, corresponding legs of all of said U-tubes lying in an inclined plane, in combination with suitable inlet and outlet connections for the ends of said tubes. Two claims.

939,237. SUPERHEATER FOR LOCOMOTIVE BOILERS. LEWIS E. FEIGHTNER, OF LIMA, OHIO, ASSIGNOR TO LIMA LOCOMOTIVE & MACHINE COMPANY, OF LIMA, OHIO, A CORPORATION OF OHIO.

Claim 2.—In a tubular locomotive boiler, the combination, with the fire-box, smoke-box, and smoke-flues connecting the same, of a tubular superheater supported in the fire-box, a smoke passage extended directly



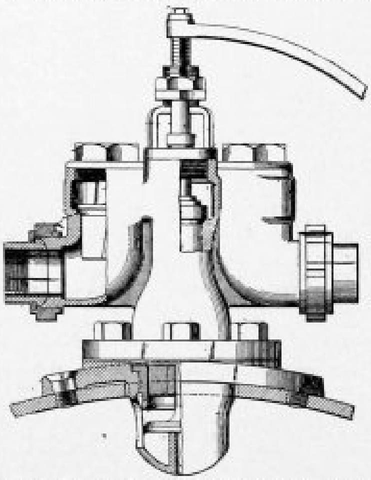
from the fire-box to the smoke-box, a cylinder steam pipe connected with the superheater outlet and extended through such smoke passage, and thence laterally through the shell of the boiler, and a damper for closing the smoke passage when the steam is not required for the cylinders. Six claims.

939,997. FURNACE. JOHN R. FORTUNE, OF DETROIT, MICH.

Claim 3.—In a furnace, the combination with grate-bars, of a bearer for supporting one end of said bars consisting of parallel sides having vertical grooves closed at their lower ends, bearing members extending across between said sides with their ends engaging said grooves, bolts extending across the bearer and through its sides adjacent to each bearing member to draw the sides together and clamp the members between them, lugs on each bearing member projecting beneath said bolts, and a clinker bar supported by said bearing members. Twelve claims.

939,310. ATTACHMENT FOR FEED-WATER INJECTORS. COLUMBUS PHILLIPS, OF MERIDIAN, MISS.

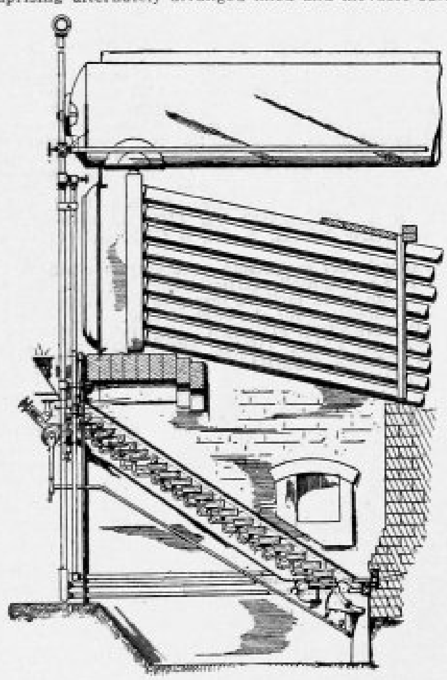
Claim 1.—The combination with a shell adapted to be secured to a boiler shell, and means of communication between the interior of the shell and the interior of the boiler, of a plurality of passages also communicating with the interior of the shell, and communicating, re-



spectively, with a source of feed-water supply, said passages being adapted to be independently cut off from communication with said source of feed-water supply, and means of cutting off any one or all of said passages from communication with the interior of the shell. Ten claims.

939,526. FURNACE. WILLIAM B. MERKEL, OF NEW YORK, N. Y., ASSIGNOR TO JOHN S. S. FULTON, OF FULLERTON, PA.

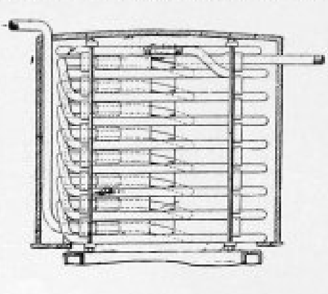
Claim 3.—In a furnace having a boiler and feed-water supply and a grate comprising alternately arranged fixed and movable bars, means for



bodily moving said movable bars, a cooling water circulating system in which both movable and fixed bars are included, and means for conducting the feed water to and through said circulating system before its entrance to the boiler. Sixteen claims.

939,759. STEAM GENERATOR. FRED NEWELL TILTON, OF HARTFORD, CONN.

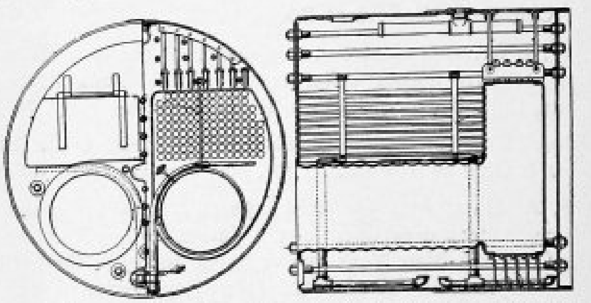
Claim 3.—A steam generator, comprising a top pipe coil, a bottom pipe coil, and intermediate pipe coils, a water inlet pipe extending between the top coil and the next following coil below and connected



with the inner end of the top pipe coil, a connection between the outer end of the said top pipe coil and the outer end of the uppermost intermediate pipe coil, a connection between the inner end of each intermediate coil and the outer end of the next pipe coil below, the connection extending over the top of the corresponding intermediate coil and then down the outside thereof to connect with the said outer end of the next following coil below, the bottom pipe coil having its inner end terminating in a steam outlet. Five claims.

939,991. WATER-CIRCULATOR FOR BOILERS. CHARLES C. ECKLIFF, OF GRAND HAVEN, MICH.

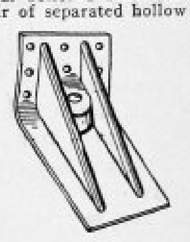
Claim 2.—A boiler, a fire chamber in the boiler, a pipe extending longitudinally within the lower part of the boiler and open at its ends, a



pipe extending vertically upward from the horizontal pipe and over the fire chamber, and a nipple on the horizontal pipe projecting into the lower end of the vertical pipe to detachably connect said pipes. Four claims.

939,368. BOILER BRACKET. WILLIAM WITHEM, OF INDIANAPOLIS, IND., ASSIGNOR TO ATLAS ENGINE WORKS, OF INDIANAPOLIS, IND., A CORPORATION OF INDIANA.

Claim 1.—A sheet metal boiler bracket having its ends bent at an angle to each other, a pair of separated hollow ribs struck up from the



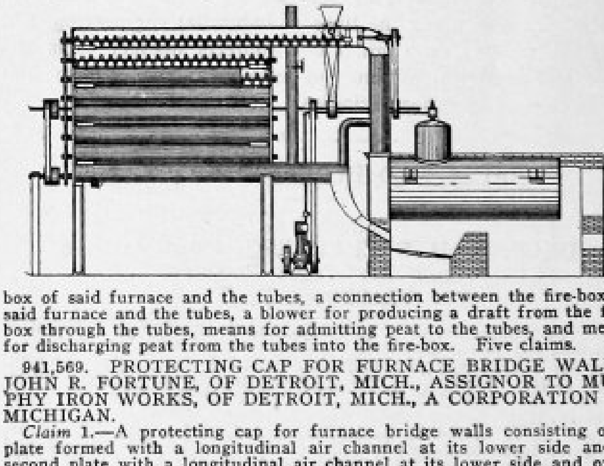
body of the sheet in the angle between the two ends, and an intermediate suspension-rod pocket struck up from the body of the plate at the bend thereof and extended partially between the adjacent faces of the two hollow ribs, substantially as shown and described. Three claims.

939,996. FURNACE FIRE-DOOR. JOHN R. FORTUNE, DETROIT, MICH.

Claim 1.—The combination of a door front having a series of openings, a lining secured to the door front and formed with a series of independent vertical passages each having an end wall adjacent to one of the openings in the door front and each passage adapted to receive air through said opening and discharge it at its opposite end. Twelve claims.

940,945. FUEL PRODUCER. WILBUR L. SHEPARD, OF ELMWOOD, AND HORACE J. WICKHAM, OF MANCHESTER, CONN.

Claim 2.—In combination with a furnace, parallel tubes with communications from one to the other at opposite ends, conveyors in said tubes, means for driving the conveyors, a connection between the smoke-



box of said furnace and the tubes, a connection between the fire-box of said furnace and the tubes, a blower for producing a draft from the fire-box through the tubes, means for admitting peat to the tubes, and means for discharging peat from the tubes into the fire-box. Five claims.

941,569. PROTECTING CAP FOR FURNACE BRIDGE WALLS. JOHN R. FORTUNE, OF DETROIT, MICH., ASSIGNOR TO MURPHY IRON WORKS, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 1.—A protecting cap for furnace bridge walls consisting of a plate formed with a longitudinal air channel at its lower side and a second plate with a longitudinal air channel at its lower side and overlapping the first plate at one edge and adjustable thereon to vary the width of the cap. Four claims.

941,547. SMOKE-PREVENTIVE APPARATUS. ISAAC M. SULLIVAN, OF SPRINGFIELD, OHIO.

Claim 1.—In smoke-preventive apparatus for furnaces, the combination with the furnace wall, of an injector head embedded in the masonry thereof with but one of its sides or faces exposed to the combustion chamber and formed of coextensive body and lip portions having the same thickness, said body portion containing a longitudinal bore forming a distributing channel and said lip portion containing a series of jet passages in communication with said channel and each of greater length than the diameter of said channel. Three claims.

THE BOILER MAKER

MARCH, 1910

A STRIKING OXY-CARBI BOILER FUSION WELD.

BY FRANK C. PERKINS.

By means of the oxy-carbi fusion welding process a most difficult piece of boiler repair work was recently accomplished, as shown in Figs. 1 and 2. It consisted of welding a patch in the flue sheet in the fire-box of a boiler. The photographs show the condition of the boiler before and after the work was accomplished. It will be noted that the work was done with the removal of only a few tubes.

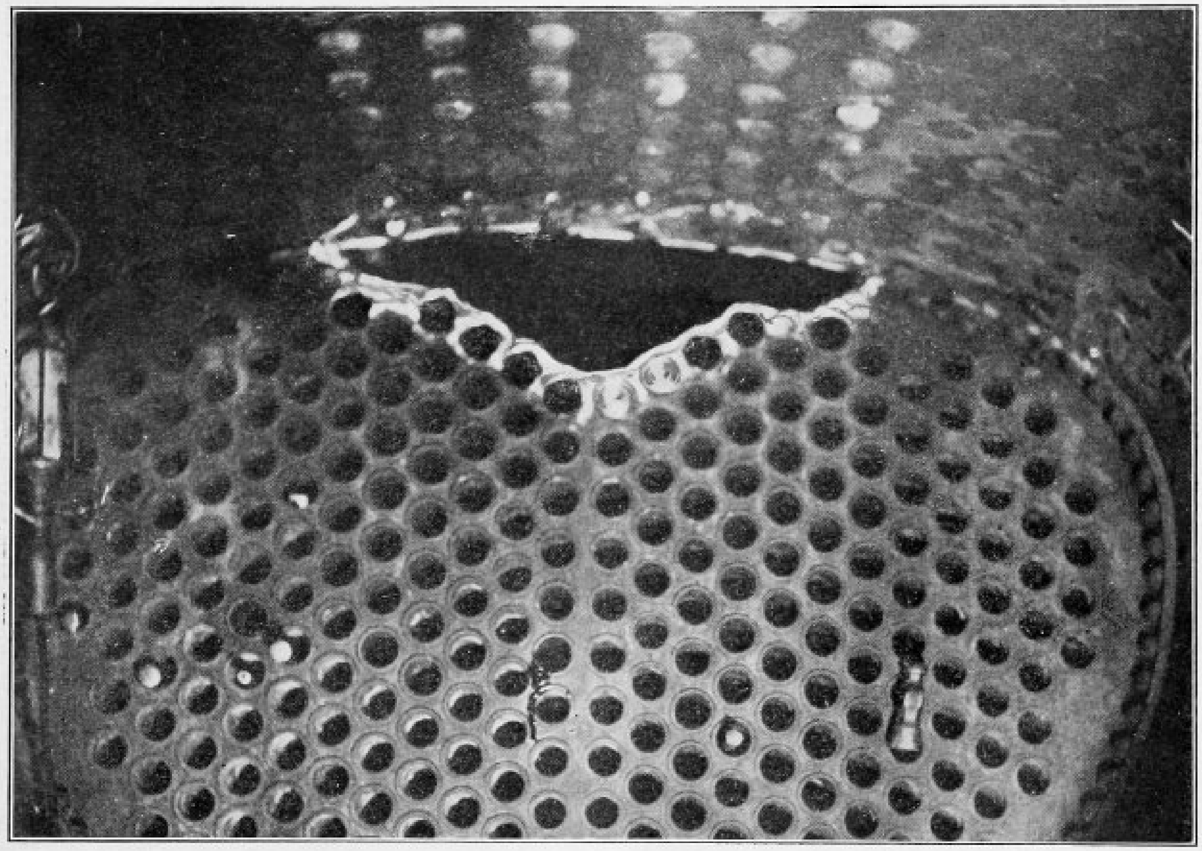


FIG. 1.

The horizontal seam is one of the most difficult sections of a boiler to repair, and to prevent gaps and cracks at the upper edge of the seam requires considerable skill on the part of the operator. The inverted seam at the flanged ends is also hard to repair and requires considerable practice and special torches and apparatus designed for the work. A portable welding machine and acetylene gas-generating equipment is desirable, as it allows the apparatus to be brought to the work, but a hydraulic pressure stationary plant may be employed as indicated in Fig. 3, with quadruple apparatus for continuous generation where the work can be brought within the range of action of such an installation.

For large work a quadruple holder, uniform pressure generator of this type is particularly well adapted and will supply acetylene gas for an indefinite period for a large number of blow pipes of the type shown in Fig. 4 without causing delay to the operators in cleaning and recharging.

The portable equipment is of great value in the repair of marine boilers in place, as well as for repairing split piping in place, welding flanges on pipe and pipe manifolding. It is available for cutting off rivet heads, restoring worn bolt holes to original size and adding on stock to any piece in any shape.

When welding the horizontal and the inverted seam of the boiler fire-box, shown in Figs. 1 and 2, the operation took 3 hours to shape the piece with the cutting torch and weld in place complete, consuming only 150 feet of oxygen. This seam was about 3 feet long, and was without doubt a repair job which demontsrated the great value of the process.

A piece of boiler plate was welded and bent as shown in Fig. 5. After crushing down under a steam hammer it showed no sign of fracture; results which are certainly remarkable for this new and unique oxy-acetylene process of fusion welding and cutting.

It may be of interest to note the results of tests with pieces of boiler plate ⅜ by 2 by 8 inches welded by this process. The welded pieces were ground flush with the surface of the plate, and it is stated that of two pieces of solid plate tested, one broke at 40,700 pounds, the elongation not being taken, while the other broke at 43,800 pounds, the elongation being .60 inch. Welded test pieces of safe end flue iron broke at 29,620 pounds, with an elongation of .17 inch, and of soft steel wire at 37,790 pounds with an elongation of .47 inch, while with basic steel wire 37,660 pounds was reached with an elongation of .70 inch.

The estimated efficiency of single riveting on ⅜-inch plate is 48.7 percent, and of double riveting 65.5 percent, while the welded pieces show the breaking point so near that of the solid stock that its efficiency is better than that of riveting.

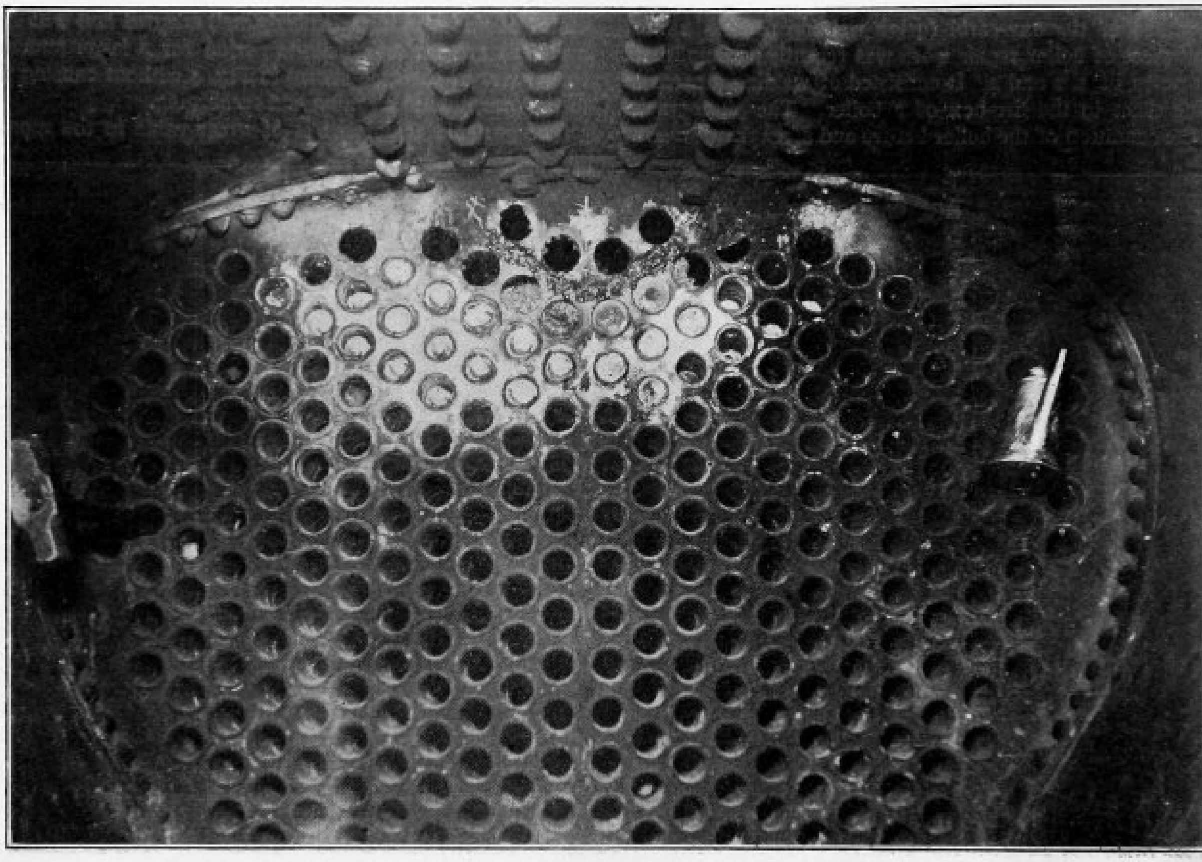


FIG. 2.

The most important part of an oxy-acetylene welding and cutting machine is said to be the torch. The torch or blowpipe as shown in Fig. 4 is constructed so as to mix the gases and at the same time preserve an absolutely uniform flame, for frequent adjustment of the flame for any reason causes the metal to warp, thus making a smooth seam impossible. In Fig. 4 a small torch is shown, with five welding tips. The larger is the combination torch with a cutting attachment ready for service. The matter of correct mixture can be regulated in this torch; a number of nozzles being supplied having different size central holes to deliver the proper size flame for different thickness of metal. The acetylene inlet is constructed so as to eliminate the possibility of flash backs. Additional flash-back preventers are placed in the acetylene pipe, effectually preventing any flame passing farther than the mixing chamber, should this in any way occur. By removing this welding tip and inserting the auxiliary nipple and screwing on the cutting nozzle it is transformed into a cutting pipe with great power of penetration. Too much oxygen always burns the metal, and too much acetylene carbonates, crystallizes and weakens the same. The torch must produce a flame positively neutral from a supply of gas under perfect control, accurately measured, and of proper pressure at the tip.

It is held that almost as important as the torch is the proper generation of acetylene gas under pressure suitable for welding. The principal drawback has been the improper slacking of the carbide which causes it to heat, even to the point of igniting in the generator. It is claimed that this is overcome in a process of cool generation by the apparatus shown in Fig. 3. A uniform pressure is obtained in this hydraulic pressure stationary plant for the continuous generation of acetylene. The pressure is maintained by the weight of the water in the standpipe, which is kept constantly filled. By alternating the charges in the carbide holder it is continuous in generation—one holder may be cleaned and recharged at any time while the other is in use—and opening the two valves to the filled holder is all that is necessary to start it working. It stops generation as soon as the consumption of gas ceases, and it wastes no gas from the safety outlet, because before this can occur the water has been so far removed from the carbide that no gas is generated. Cleaning and re-charging is the work of but a few minutes without the necessity of handling trays or pans. Opening the large gate valve in the bottom of the apparatus allows the sludge to empty in the sewer or catch basin; a little flushing with the hose cleans the holder, when it can again be filled with carbide, the cover clamped on, and the holder is ready for use as soon as the other is exhausted.

This variable-pressure generator may be set at any pressure desired from 0 to 15 pounds, and the pressure is maintained by a connection with a water supply from some source where a pressure equal to that desired on the gas may be had. This apparatus is built with one, two and four carbide holders, the double and quadruple holders being continuous. It is exceedingly simple, and entirely automatic. It is claimed that it may be run indefinitely with the largest size blowpipes, using

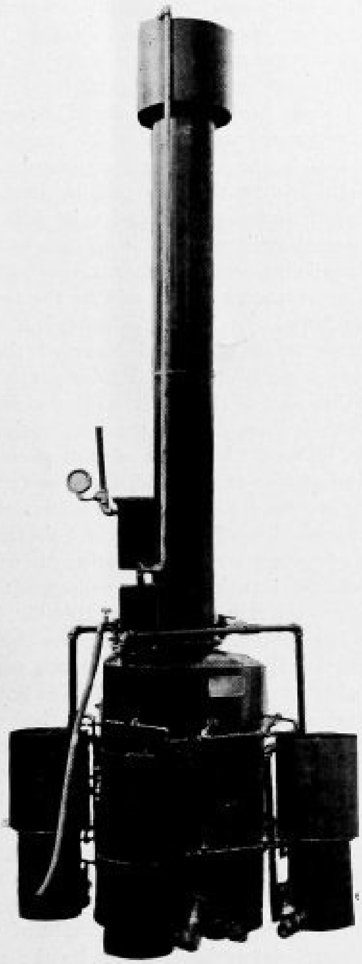


FIG. 3.

200 pounds of carbide in 10 hours without overheating or clogging, or causing any delay to the operators. Generation is governed by consumption. When consumption ceases, generation ceases, consequently there is no waste from after generation.

RELATIVE EFFICIENCIES OF YORKSHIRE AND LANCASHIRE BOILERS.

BY CHARLES TRAVIS.

A modified form of the well-established type of boiler known as the "Lancashire" boiler has recently been proposed, which the inventors propose to call the "Yorkshire" boiler. Its chief features and the advantages claimed for it may be summarized as follows, to quote an expert: The ordinary Lancashire boiler consists of a main cylindrical shell, about 8 feet in diameter, and 30 feet in length, with two internal parallel flues about 3 feet, or slightly more in diameter, with the exception of the last two rings, which are tapered down to a very small diameter. Externally the new so-called Yorkshire boiler is precisely similar, except that its length is very considerably curtailed, to the extent of a fifth or a third; that is, to 24 or 20 feet, while internally there are also two flues, which, however, slope upwards, so that the tops of the flues are about 6½ inches nearer the water level at the back of the boiler than over the fire grate. The important feature of these flues is that they taper with a cross section at the back about 50 percent greater than at the front; in all other respects, such as the setting, the Yorkshire boiler corresponds with the Lancashire type.

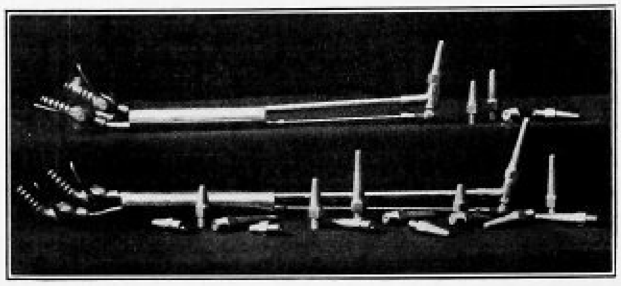


FIG. 4.

The inventors claim the following advantages: That the cost of the boiler with its setting is reduced about $500; that radiation and brickwork losses are necessarily very considerably diminished, and, most important of all, that the efficiency is bettered fully 10 percent. It is claimed that a higher evaporation by from 10 to 15 percent can be obtained from a 24 feet by 8 feet Yorkshire boiler than from the present type of 30 feet by 8 feet Lancashire boiler. The inventors point out that the taper of the flues brings the bulk of the water nearer to the furnace, where most of the heat is transmitted to the water; as now designed there are in the first 6 feet of the Yorkshire boiler 253 pounds of water per square foot of

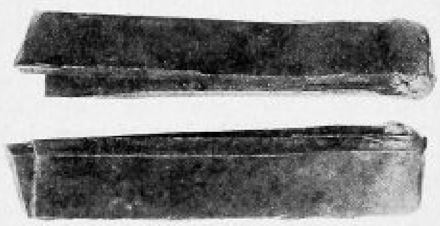


FIG. 5.

heating surface, compared with only 172 pounds in the ordinary Lancashire boiler, while at the back of the boiler the proportions are reversed, namely, 90 pounds for the new type and 102 pounds for the old one now in general use. An advantage is also claimed, due to the assured fact that the transference of heat over the furnaces is greater in the Yorkshire boiler, on account of the greater body of water. In support of this opinion the inventors rely on the experiments of Sir William Anderson and Sir E. Bramwell, both noted engineers, which show that the heat transmitted through a boiler plate is two and one-quarter times as great when the water is actually boiling as when the water is dead. The proposed taper of the flues results, it is claimed, in a further advantage, as it enables the flues, owing to their being smaller in diameter at the furnace end, to be placed lower in the boiler, which results in two gains, as it somewhat reduces the risk of the furnace crowns becoming overheated through shortness of water, and it should be of assistance in improving the water circulation. The inventors believe that the heat transmitted to the water increases with the velocity of the gases, and therefore claim that the narrowing of the flues at the furnace end speeds up the gases and thus increases the rate of heat transmission where the larger proportion of water is. Adopting the two and one-quarter ratio of Anderson and Bramwell for boiling, as compared with dead water, the inventors state that the whole flue area of the shorter boiler being active transmits two and one-half times as much heat per square foot as the latter two-thirds of the longer boiler; on which basis the new Yorkshire boiler would evaporate a few percent more water than a Lancashire boiler of equal diameter.

The inventors were led up to the design of the Yorkshire boiler by a knowledge that steam coal contains, approximately, 60 percent to 65 percent of fixed carbon or coke, and from 15 percent to 20 percent of gaseous products, these passing along the flues in the form of smoke or flame, according to the condition of the fires, but the whole of the radiant heat is absorbed over or near to the points of emission, namely, the furnaces. Assuming, then, a 30-foot by 8-foot 6-inch boiler having about 105 square feet of heating surface, the first 8 feet of the furnace flues only equal a little over 100 square feet. Sixty percent of the heat generated is absorbed by 10 percent of the boiler heating surface, and as 15 percent of this, at least, is required for producing the necessary draft, only 25 percent of the heat is left to deal with the remaining 90 percent of the boiler-heating surface.

The Yorkshire boiler is designed in such a manner that the heat and water are proportionately distributed between the two end plates, the minimum heating surface, high temperature and the maximum head of water at one end and the maximum heating surface, low temperature and minimum head of water at the other end, and, as the sectional area of the furnace flues in the center of the boiler is 21 percent less than in a Lancashire boiler of equal diameter, the velocity of the gases and their density are 21 percent greater, thus giving the necessary conditions for quick steaming; that is, good circulation inside the boiler and a rapid travel of gases over that part where the most work is done after that of the radiation from the furnaces.

The only rational method of testing two boilers of approximately similar types is to burn in each similar weights of fuel per hour and then to decide the efficiency by the weight of water evaporated. Such tests have been made recently and the following details clearly prove that a small, active heating surface, as in the Yorkshire type of boiler, is both more efficient and will give a higher evaporation per hour than the larger heating surface of the Lancashire boiler. A Yorkshire boiler 20 feet long and 8 feet 6 inches diameter evaporated 7.238 pounds of water per hour. Speed of gases at the center of the flue, 1,100 feet per minute; evaporation per square foot of flue heating surface, 22 pounds per hour; by increasing the weight of fuel burned to 2,000 pounds per hour, the evaporation rose to 17.437 pounds, and the speed of the gases to 4,250 feet per minute, the evaporation per square foot of flue area being 53 pounds.

In comparison, take a 30-foot by 8-foot 6-inch Lancashire boiler burning 904 pounds of fuel, and 2,184 pounds, respectively, the evaporation is 8,400 pounds and 16,598 pounds per hour; the speeds of the gases, 1,520 feet and 3,664 feet, and the evaporations per square foot of furnace flue 15 pounds and 31 pounds. A comparative test with a 24-foot by 9-foot Yorkshire, and a 30-foot by 9-foot Lancashire, each burning 1,436 pounds of smudge per hour, with a feed of 129 degrees F., no economizer being used, and the discharge from each going into the same chimney, showed: that the Yorkshire evaporated 7.1 pounds of water per pound of fuel, and the Lancashire 6.54 pounds, the respective hourly evaporations being 10,360 pounds and 9,531 pounds. This test indicates that large heating surfaces are not essential. The Yorkshire boiler has 23 percent less area than the Lancashire, but the sectional area at the center of the furnace flues is 20 percent less than in the Lancashire therefore, the speed of the gases is 20 percent higher, the result being an increased transmission of heat and, therefore, greater evaporation. There are now over twenty Yorkshire boilers working in varying sizes from 20 feet by 8 feet to 24 feet by 9 feet, and the results given above are the worst results secured.

Experts and engineers who prefer the Lancashire type of boiler criticise the above as follows: They assert that the laws of heat transmission give no support at all to the theory or claim that the suggested taper of the flues brings the bulk of the water nearer the furnace, and that consequently the transmission of heat over the furnaces is greater; they assert that, other things being equal, the quantity of heat passing into the water is quite independent of the quantity of the water. They also suggest that recent experiments by a well-known expert, Wm. Bilbrough, in the Transvaal, who repeated those made by Sir William Anderson and Sir E. Bramwell, showed no difference whatever, and that for the present the experiments of the two latter prominent engineers cannot be accepted. Should, however, the difference in the rate of evaporation between boiling and dead water exist, it is asserted that it is difficult to see how it supports the claims of the inventors of the Yorkshire boiler, as the greater the proportion of water is to the heating surface, the less will be the temperature of the water, and, therefore, violent ebullition is less possible.

With reference to the proposed taper of the flues, it is pointed out that it necessitates a smaller grate area in proportion to the diameter of the boiler, so that either the rate of combustion must be increased, or the evaporative capacity of the boiler must be lowered. If the advantage claimed for the Yorkshire boiler can be made good, there is (experts claim) no reason why the flues of Lancashire boilers should not be made smaller and be placed lower in the boilers, so as to obtain the same advantages. With regard to the claim that the narrowing of the flues at the furnace end speeds up the gases and thus increases the rate of heat transmission, it is asserted that the claim is unsound. In the first place the greater part of the heat entering the boiler in the furnace section does so by radiation; the inventors of the Yorkshire boilers estimate this radiant heat at 80 percent, which may be too high, and, therefore, it cannot be affected by the speed of the gases. The speed of the gases is most important at the rear of the boiler, where the radiant heat is quite small, but here the Yorkshire boiler reduces the velocity by opening out the flues and thus reducing the effectiveness of the heating surface. In the second place, it is not fair to assume that the velocity in the furnace of a Yorkshire boiler is different from that in a Lancashire boiler. The evaporative capacity of any boiler is an arbitrary figure, determined chiefly by the rate of combustion, which in its turn, depends upon the draught and the quality of the coal.

In comparing boilers of approximately similar type and duty, the only rational method is to adopt the same rate of combustion in all cases. If this is done in the comparison before us, the velocity of the gases over the fires is the same in both cases, but is less at the back of the boiler in the case of the Yorkshire boiler. The inventors assert that a greater proportion of heat is abstracted at a distance from the fires, also that this secures at the front, where the larger head of water is located the greatest transmission of heat, and, further, that the expansion also gives at the rear of the boiler, where the temperature is lowest, the largest area of heating surface, and the minimum head of water, and this expansion of the flues and the upward inclination further assists in maintaining the velocity of the gases; the total result being that the heat and the water are proportionately distributed throughout the boiler, hence more work is done by the smaller furnaces and heating surface. This is described as loose reasoning; how the expansion in the flue area can maintain the velocity of the gases is difficult to understand; it ought also to be stated how, if the rear end of the boiler takes upon itself a larger share of the duty, more work is done by the smaller furnaces; generally if one relieves the furnace of its duty, it does less work.

Assuming that the Anderson and Bramwell ratio of two and one-quarter for boiling, as compared with dead water, is correct, the inventors state; that the whole flue area of the shorter boiler being active, transmits two and one-quarter times as much heat per square foot as the latter two-thirds of the longer boiler. On this basis the Yorkshire boiler would evaporate a few percent more water than the Lancashire of equal diameter, but if, as seems likely, the two and one-quarter ratio does not hold, then the Yorkshire boiler will be much less efficient than the older rival. Any boiler can be made greatly to exceed its normal evaporation, and if given sufficient draft any Lancashire boiler will evaporate double what is usually considered a fair quantity. Further, the last section of any through flue boiler is notoriously relatively inefficient, and cutting off a few feet from a Lancashire boiler would not seriously affect its efficiency, especially if it were provided with a good economizer. So much for the opinions of experts for and against the new type of boiler. As a considerable number are now in daily use, a few years' actual experience will decide the points of difference.

THE POWERING OF BOILER SHOPS.

BY D. S. DOWNS.

The electrical systems which fulfill the power requirements of the boiler shop may be divided into two distinct classes, with a third, which is a combination of the two main classes. These are the alternating-current system, the direct-current system and the combination of the direct current for main units and the alternating current for auxiliary, or with alternating current as main units and the direct current as auxiliary. In determining which of these systems is best suited for boiler shop service a variety of opinions is offered, and a choice is only arrived at by careful consideration of the prevailing conditions.

Each of the above systems will be taken up separately and discussed with reference to the particular application of the system and the classes of service which can be handled efficiently and economically. In discussing the relative advantages of the different systems reference will be made to a boiler shop of the latest design and average capacity. The question of changing from a mechanically operated to an electrically-operated plant will not be considered. It may be said, however, at the start that in such a case the direct-current system is usually more satisfactory for a small shop, while for a plant of considerable capacity equipped with old-style tools the alternating-current system should be generally made without hesitation. In such cases whatever direct current is needed may be obtained by means of a motor generator set if the capacity required is small, or by a rotary converter where a considerable amount of current is necessary.

ELECTRICAL SYSTEMS.

When the distances over which current must be transmitted are considerable, the alternating system offers the advantages of reduced energy loss between the switchboard and the machine consuming the energy. Current can be generated at high voltages and transmitted throughout an alternating-current distributing system with a considerable saving in copper as well as a reduced loss of energy in transmission. A limit, however, is placed upon the transmission voltage of such a system, due to the fact that auxiliary apparatus is necessary in the way of transformers to bring the voltage of the system down to a practical operating voltage. It is, therefore, easily seen that a point may be reached when a saving from reduced copper and energy lost in transmission is offset by an additional investment in apparatus, which in case of a change of systems is a decided loss.

There are certain conditions which determine without hesitation that the alternating-current system is the most applicable and economical, while in other cases, where the character of the power service is more or less varied, a careful study of the conditions is necessary to effect a choice. For instance, for a plant which covers a large area and has an equipment demanding large amounts of current, of which only a small portion is used for variable speed machinery, and which is of sufficient size to require separate units for the lighting service, alternating current is the only logical solution. On the other hand, for a plant having all its departments

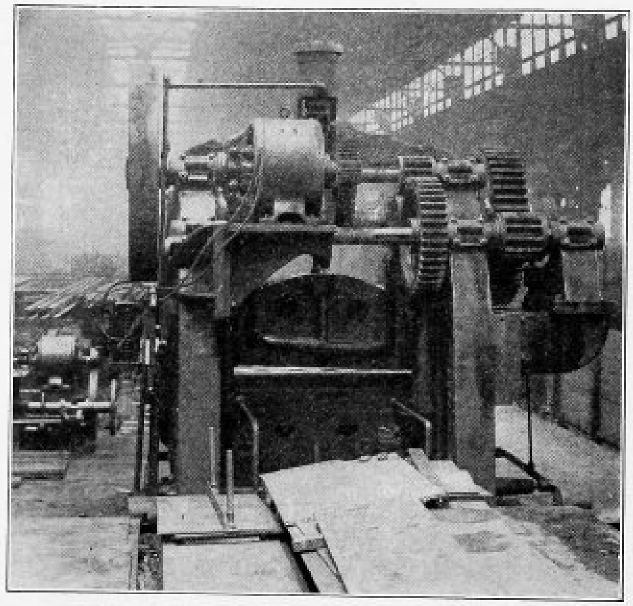


FIG. 1.—MOTOR-DRIVEN SHEAR PRESS.

closely centered and compactly arranged, and having an equipment consisting of variable speed machinery, the direct-current system is the proper solution, with individual connected motors wherever possible. In general, no hard and fast rule can be laid down as to which system shall be most economical. Conditions are often most complicated, making it necessary for the most careful investigation of the installation and a thorough knowledge of the present power demands as well as some knowledge of future expansion.

ALTERNATING-CURRENT MOTORS.

For use on the alternating-current system two types of motors, in general, are of importance—the synchronous and the induction motor. The former is not self-starting, and except in a few cases its place in machine tool driving is limited. Its use, however, is recognized in connection with induction motors for steadying the line and improving the power factor where heavy shafts are to be run for some length of time. The induction motor is self-starting, and like the synchronous motor tends to run at a constant speed. Although primarily for constant speed use, the induction motor may be adapted to variable speed service. In those installations using alternating-current motors, principally on constant speed machines, the induction motor in connection with a mechanical speed-changing device, generally proves very successful for variable speed demands. In other cases, for use on cranes and other hoisting devices, variable speed is very often obtained through the phase-wound induction motor by the cutting in of resistance in the secondary to obtain the proper starting torque. In general, however, with the exception of the last-named classes of service, variable speed is most satisfactorily obtained through speed-changing devices.

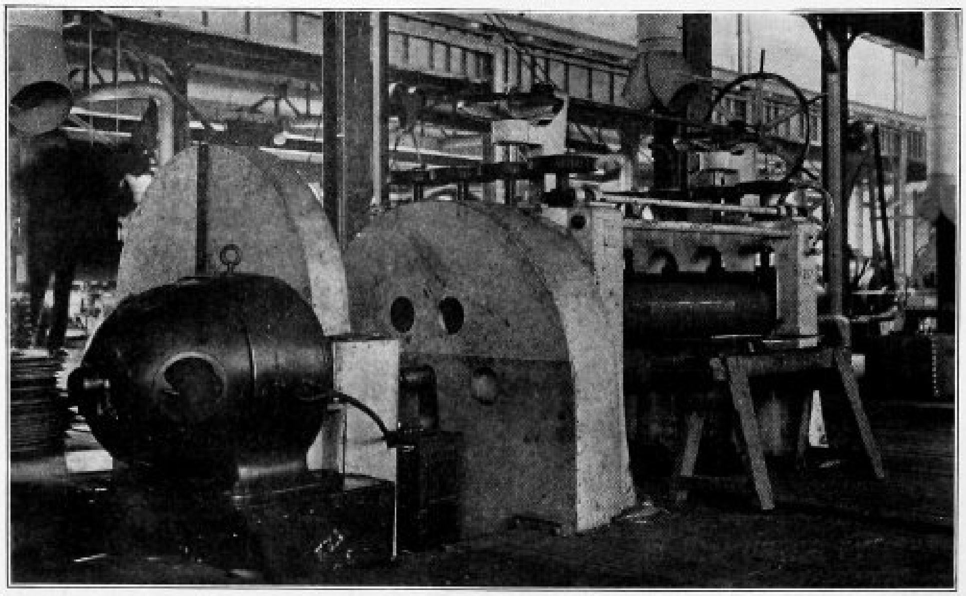


FIG. 2.—MOTOR-DRIVEN PLATE-STRAIGHTENING ROLLS.

The constant speed characteristics of the induction motor make this type of motor especially applicable to boiler shop service. The relation between torque and speed in the induction motor operation is the one which shows up this feature. When the load is put on a motor its speed falls until the induced electromotive force in the secondary is sufficient to develop the torque required for the load. As the load increases the torque increases until a certain point is reached, when the speed decreases and the motor stops. This point is known as the pull-out point. A torque developed is directly proportional to the watts in-put to the secondary, and varies as the square of the voltage impressed upon the primary winding. The constant speed induction motor has a very small slip, and, therefore, high efficiency and a very good speed regulation, running at nearly constant speed from no load to moderate overload. The induction motor is free from commutator troubles, which is especially valuable in a very dusty place or where fine chips are made.

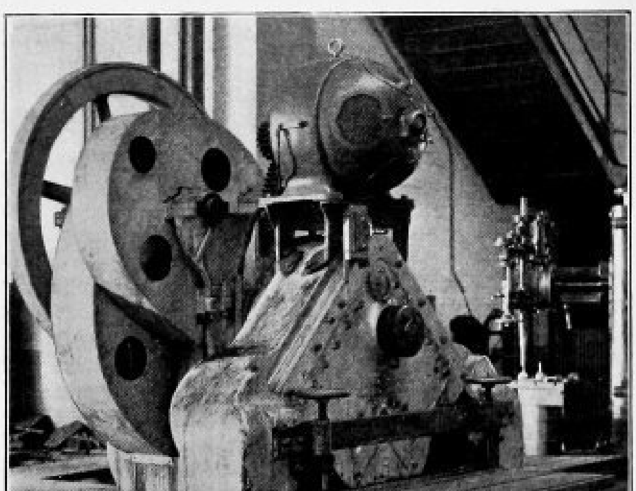


FIG. 3.—MOTOR-DRIVEN BAR CUTTER.

DIRECT-CURRENT MOTORS.

The direct-current system offers three types of motors, the combined characteristics of which cover very thoroughly the requirements of boiler shop machine tool driving. These types are the series-wound, compound-wound and the shunt-wound motors.

The series motor is a variable speed motor with great starting torque, and can be controlled throughout its whole range of speed. It is, however, very uneconomical, as the control is obtained by resistance in its circuit, requiring an expensive controller on account of the heavy currents handled. The speed varies inversely with the load, so that at light loads the speed attained makes it dangerous to the construction of the armature. At no load the speed increases to such a point that it is said to "run away." The series motor gives excellent service on cranes, elevators and hoists, and occupies a very important place in direct-current equipments.

A compound motor is suitable where small variations of speed are needed coupled with a large starting torque. When set for certain conditions this type of motor operates at a constant speed.

The shunt motor is essentially a constant-speed motor. When set to run at a given speed it will not vary appreciably under a varying load up to its capacity. The motor can be made to vary in speed in a number of ways, however. By varying the current in the armature, by varying the strength of the field, and by varying the voltage applied to the armature terminals, various speed regulations may be obtained. These characteristics make the shunt motor the most suitable of any type of the direct-current motor for the purposes of machine tool driving. By means of these three methods of control, either singly or in combination with each other, or in combination with gearing, this type of motor can be made to fulfill the requirements of both variable and constant-speed machines.

The third system to be considered is the alternating-current direct-current system. This combination has its advantages, especially where it is possible to purchase current from a large power company delivering alternating current. Again, it has its advantages in the case already mentioned of a widely separated plant of large proportions where variable speed figures.

In the case of purchasing power under these conditions transformers reduce the voltage to the proper point at the distributing board of the plant, and the low-voltage alternating current can then be used for all power requirements except for driving variable-speed motors and auxiliary apparatus, such as magnetic clutches, lifting magnets, etc. The serious objection to this arrangement for the boiler shop is the absolute helplessness in case of accident to the supply of energy. With the source of power cut off and no auxiliary power plant to fall back on the output is absolutely unprotected.

In the case of a plant provided with its own generating equipment a more reliable system as well as economical layout is assured. Alternating current can be used for all constant speed and lighting service, while motor generator sets, or a rotary converter, can be provided to supplement the system and supply the direct current for variable-speed motors and auxiliary apparatus. For this system the method of application of the motor to the machine, the selection of the motor and the lines along which economical results may be expected, are at the present time well determined.

Generally speaking, drill presses and radial drills used in the boiler shop do not require a frequent change of speed, and an individual motor drive direct connected is usual practice. Provision for change of speed is usually provided on standard drills, so that any constant-speed motor may be used.

In the cases of punches, shears and bending rolls they are usually placed in boiler shops under cranes and in such locations as to give convenient operation on the work. In the parts of the shop where the work demands machinery of this nature, there is usually a small amount of machinery, and each machine is usually individually driven by direct-connected motors. None of this class of machines requires variable speed, so that a constant-speed motor, alternating current or direct current, operates satisfactorily.

Fig. 1 shows the direct application of a direct-current constant-speed motor to a heavy type shear. It will be noted that the motor is heavily geared, and that the power is delivered to the shear through a reduction of gearing. It will also be noted that a heavy fly-wheel is used on the motor shaft. This arrangement is good practice with motor-driven punches and shears of the heavy type, since the fly-wheel stores the energy delivered by the motor on the non-working stroke and on the working stroke returns it to the motor, thus avoiding a heavy drawing of current by the motor at the working stroke.

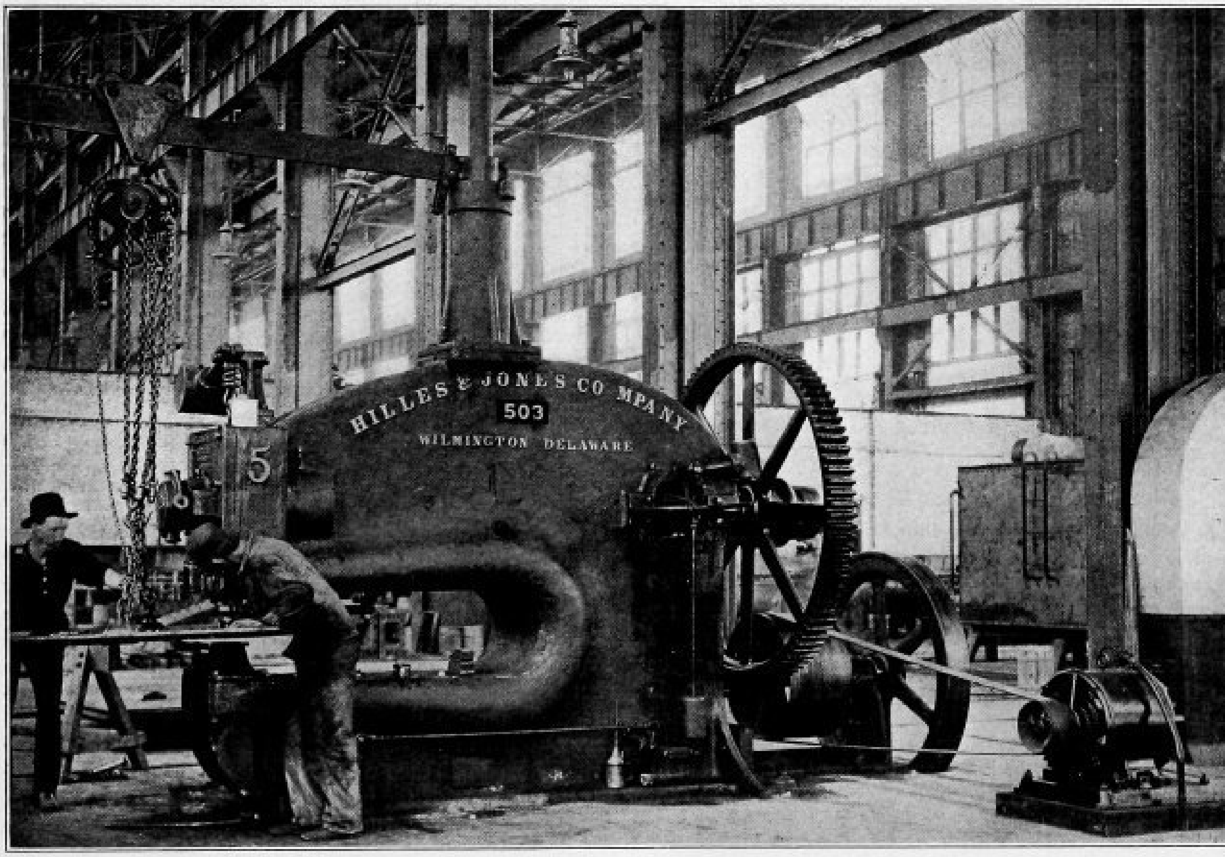


FIG. 4.—MOTOR-DRIVEN PUNCH.

Fig. 2 shows another application of the constant-speed motor to bending rolls. It will be noted that the power required by the operation of this machine is constant, and that the direct-connected motor properly reduced by gears makes it a very economical drive. The motor shown is a Crocker-Wheeler enclosed type direct current. The enclosed feature protects from any dust or foreign substance getting in the commutator or armature.

Figs. 3 and 4 also show applications of the electric motor where economy of power, economy of space and flexibility of arrangement are most important. They not only illustrate the possibility of getting more out of the machines individually by the arrangement, but of gaining flexibility in the handling of the work.

Aside from the application shown, the use of motors for driving traveling cranes is one of the features of the modern boiler shop which cannot be over-estimated. Few shops are over-supplied with crane service, while in a great many cases they are altogether too few and too poorly equipped.

At the present time only an extensive study of boiler shop economy will disclose the saving in power and the other relative advantages which can be effected by the proper installation of the electric drive. It is thoroughly recognized at present that the proper time for this study is during the design of the plant and not later, when a heavy demand on the shop necessitates a change in order to increase the output.

LAYING OUT A WRAPPER SHEET FOR A LOCOMOTIVE FIRE-BOX.

BY W. E. O'CONNOR.

There are some types of locomotive fire-boxes with the door sheet lower than the flue sheet at the crown, and with the door sheet inclined to the flue sheet at an angle, but of the same width throughout. This problem may be readily laid out by the method of projection. There are other types of locomotive fire-boxes, with the door sheet lower than the flue sheet at the crown, also with the door sheet inclined to the flue sheet at an angle, but with the door sheet considerably narrower, at the center line of the boiler than the flue sheet, but of the same width at the foundation ring. This problem may be laid out in various ways by the method of triangulation.

It is the latter type of which the writer intends to describe briefly the method in vogue where he is employed. To do this a smaller number of division points have been taken than would actually be taken in order to avoid confusion. I may also add, in tracing out the boundary line for the stretchout of the pattern this should be the rivet line. With this much information proceed as follows:

In the center of your sheet, from which you wish to make your wrapper, draw up a full-size side elevation of the fire-box, also a half-end view of the door and a half-end view of the flue sheet, vertical lines *R-D* and *S-H* of the side elevation representing the rivet lines and the curved lines in the end views representing the neutral lines of the material used, as shown at Fig. 1. Care should be used in the construction of the foregoing, since it is the foundation for all future measurements.

Next divide the half view of the door and flue sheet into a like number of equal parts (as small as possible). In this case four have been taken. Project the points so found to the center line or axis of the heads, as shown, 2-*A*, 3-*B*, 4-*C* to 5-*D* on the door sheet, and 2-*E*, 3-*F*, 4-*G*, etc., to 5-*H* on the flue sheet. These lines, *A-E*, *B-F* and *C-G*, represent the horizontal distances between the door sheet and the flue sheet.

Since the door sheet is narrower at the center line of the boiler, and yet inclined at an angle to the latter, it is very evident that if a right triangle be constructed for each of the following sets of division points, *A-E*, *B-F* and *C-G*, with a base equal in length to the difference of the corresponding chords, then will the hypothenus be the true length of the lines sought. To do this, with a radius equal in length to chord *A*-2 on the door sheet, and using point *E* as a center, draw an arc locating point *t* on chord *E*-2 of the flue sheet. In a similar manner transfer *B*-3 and *C*-4 to corresponding chords on the flue sheet, locating points *u* and *v*. Now, erect perpendiculars to the horizontal lines from the points *E*, *F* and *G* equal in length to *t*-2, *u*-3 and *v*-4, as shown by the points *I*, *J* and *K*, then will the distances *A-I*, *B-J* and *C-K* be the true lengths of the lines sought. Since the lines *R-S* and *D-H* represent their true lengths, it will be observed that we

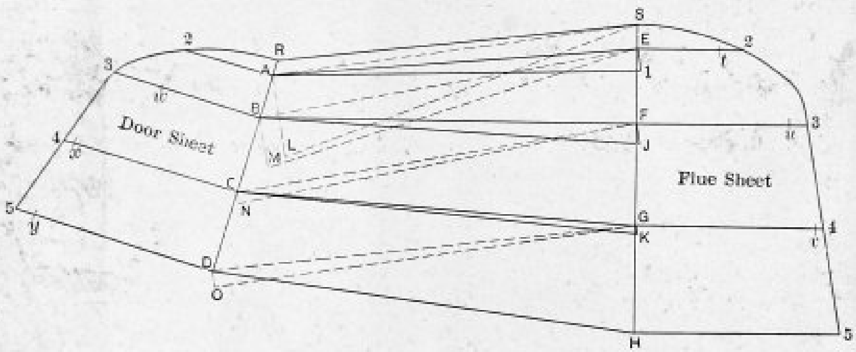


FIG. 1.

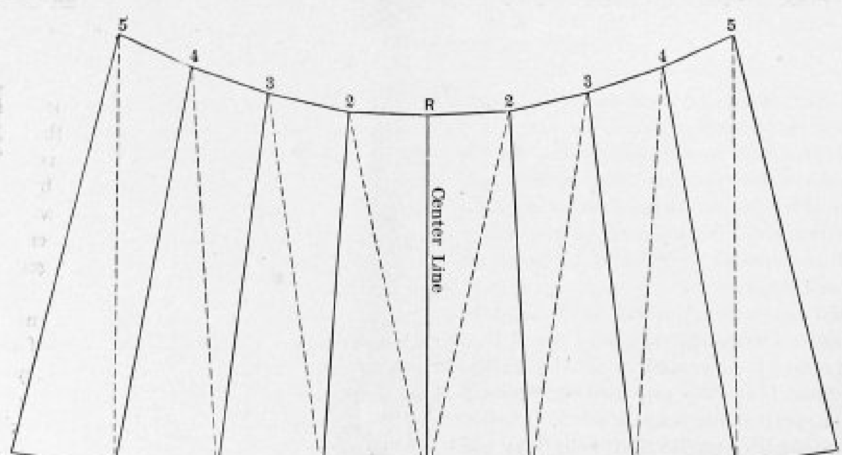


FIG. 2.

have obtained the true distance between the principal points of intersection. In like manner any number of intermediate points may be found.

Next, construct the diagonal right triangle *S-A-L*, and make *A-L* perpendicular to *A-S* and equal in length to chord *A*-2, make *B-M* perpendicular to *B-E* and equal in length to *w*-3, which is the difference in length of chord *E*-2 and chord *B*-3. Make *C-N* perpendicular to *C-F* and equal in length to *x*-4, which is the difference in length of chord *F*-3 and chord *C*-4. Also make *D-O* perpendicular to *D-G* and equal in length to *y*-5, which is the difference in length of chord *G*-4 and chord *D*-5. Then will the sides *L-S, M-E, N-F* and *O-G* be the true lengths of the diagonal lines.

To lay out the pattern, first draw the center line *R-S*, Fig. 2, make *R-S* equal in length to *R-S*, Fig. 1. Then with one pair of dividers, set equal to division space *R*-2 of the door sheet, and using point *R* of the pattern as a center, draw arcs 2, 2. Now, with a radius equal to the diagonal distance *L-S*, Fig. 1, and point *S*, Fig. 2, as a center, intersect the arcs 2, 2 previously drawn. Then with a second pair of dividers, set equal to division space *S*-2, Fig. 1, of the flue sheet, and point *S*, Fig. 2, as a center, draw the arcs *A-A* as shown. Then with radius *A-I*, Fig. 1, and using points 2-2, Fig. 2, as centers, intersect the arcs *A-A*. Since the remaining points on the pattern are located in a similar way no further explanation is necessary.

The pattern should now be checked up from the center line; it must be understood that this includes the relative position of the four points 5-5 and *D-D* with respect to points *R* and *S* of the center line. Whence the contour for the rivet line to suit extended flanges at the crown, also angular shaped corners at the mud-ring, may now be placed in. The rivet holes are then properly spaced and punched 1/16 inch small, and reamed to size in place.

COMPRESSED AIR FOR PNEUMATIC HAMMERS.

It is to be regretted that through a mistaken policy in the beginning, many of the manufacturers of pneumatic tools have heretofore resorted to the publication of what are really "nominal ratings" for the cubic feet of air required to drive their machines. This condition of affairs is similar to that in the automobile business, where a tendency to overrate the engine power in many cases is well known. The excuse for such procedure is that the other fellow does it, and consequently if any manufacturer has the backbone to give the real figures, his machines will not compare so favorably on paper with those of his competitor.

Some measure of excuse may be granted when it is said that most of the figures given for air required to drive pneumatic tools are based upon calculation and estimation only, as the actual measurement of the air required to drive any machine is a little difficult to accomplish without special apparatus. As a matter of fact pneumatic tools of different makes do not vary a great deal in their air consumption for a given amount of work done, and so, for estimation purposes for the installation of a suitable compressor, the figures given in the accompanying table are of timely interest.

In this table are given the actual cubic feet of free air required per minute and the power to operate from one to fifty pneumatic hammers of the cylinder diameters and strokes shown. The quantities of free air for one tool have been obtained by careful experimenters with special water-displacement apparatus, and being the averages of a great many readings, may be taken as accurate and fairly representative for most tools of similar dimensions. The figures for more than one tool were obtained by deducting 2 percent for every five tools; that is, five chipping hammers are assumed to require 4.8 times as much air as one chipping hammer of equal size. Ten hammers are assumed to require 9.6 times as much as one hammer, and so on. This is to allow for the intermittent action of different tools in a shop, and this basis of calculation agrees very nicely with observed shop practice.

The quantities of air, as shown by the larger figures in the table, are actual cubic feet of free air required at atmospheric pressure at sea level, this air being delivered to the tool at 80 pounds pressure. The figures for horsepower, which are the smaller figures in the table, assume compound compression to 85 pounds pressure; that is, allowing 5 pounds drop in the pipe line. The figures for power also include reasonable friction of the compressor and the usual losses of power in the air cylinder of an air compressor of reasonably good design. They would represent just about the brake-horsepower required from an electric motor to drive a compressor actually delivering the quantity of air given by the large figures above them.

This brings up the point of the volumetric efficiency of the compressor. As the quantities shown were obtained by actual measurement of air used, it is imperative that the output of the

TABLE OF ACTUAL CUBIC FEET OF FREE AIR REQUIRED PER MINUTE AND POWER TO OPERATE FROM 1 TO 50 PNEUMATIC HAMMERS OF THE SIZES SHOWN.

Number of Tools	Diameter Stroke.	1	5	10	15	20	25	30	35	40	45	50
Chipping Hammers	1 1/8" x 1"	14 2·6	69 13	134 25	197 37	258 48	315 59	370 69	421 79	470 88	517 96	560 104
	1 1/8" x 2"	17 3·2	18 16	163 30	240 45	313 58	383 71	449 84	512 95	571 106	627 117	680 127
	1 1/8" x 3"	20 3·7	98 18	192 36	282 52	368 69	450 84	528 98	602 112	672 125	738 137	800 149
	1 1/8" x 4"	22 4·1	108 20	211 39	310 58	405 75	495 92	581 108	662 123	739 138	812 151	880 164
	1 1/8" x 5"	25 4·7	123 23	240 45	353 66	460 86	560 105	660 123	753 140	840 156	923 172	1000 186
Riveters	1 3/16" x 6"	33 6·1	162 30	317 59	465 87	607 113	743 138	875 163	993 185	1109 206	1218 227	1320 246
	1 3/16" x 8"	36 6·7	176 33	346 64	508 95	662 123	810 151	950 177	1084 202	1210 225	1328 247	1440 268
	1 3/16" x 9"	38 7·1	186 35	365 68	536 100	699 130	855 159	1003 187	1144 213	1277 238	1402 261	1520 283

Large figures are free air, and small figures are horsepower to drive compressor. Figures for air are for 80 pounds pressure at sea level, and are based on ordinary intermittent service, as is usual in any shop. Ratings for one hammer are actual readings from water displacement tests, being averages of many trials. Horsepower figures assume compound air compression to 85 pounds pressure, and include friction. For single stage compression to 85 pounds add 15 percent. to power figures. Compressor displacement required should include volumetric loss, as figures are for actual air delivered.

compressor shall be equal to this. To allow for volumetric efficiency loss, this necessitates that the piston displacement of the compressor shall be greater than these figures by from 8 to 12 percent, depending upon its design. The figures for power required include this loss, as they represent the power necessary to actually deliver the quantities of air shown as the actual output of the compressor.

In cases where single-stage compression is used the power required may be obtained by adding about 15 percent to the power figures given. This, of course, has no effect upon the air quantity.

It has been stated that these figures are for sea-level operation. This will be satisfactory for most localities, but at 5,000 feet elevation 17 percent more free air capacity will be required and about 7 percent more horsepower for the same size and number of tools. These increases are practically proportional to the altitude.—S. B. R. in the *American Machinist.*

ends. We are able to cut off about ten ends per minute. The machine has been in constant service for the past ten years, and has cost us very little in the way of repairs.

A suitable flue-welding furnace is a very necessary adjunct in obtaining the best results in flue welding. We have also prepared a drawing of the furnace in use at the Sunbury shops. This particular furnace was designed by the writer, and he feels that it accomplishes all he claims for it. The furnace is very simple in design and construction. There are about 260 bricks used in its original construction, and it is good for about one year's service before it is necessary to rebuild it, except at the orifice where the welding heat is taken. At that point the wear is greatest, and the brick must be renewed about once in every two or three months. This process requires the expenditure of about two hours' labor and eight or ten brick. The maximum number of flues welded without rebuilding the furnace was 7,700.

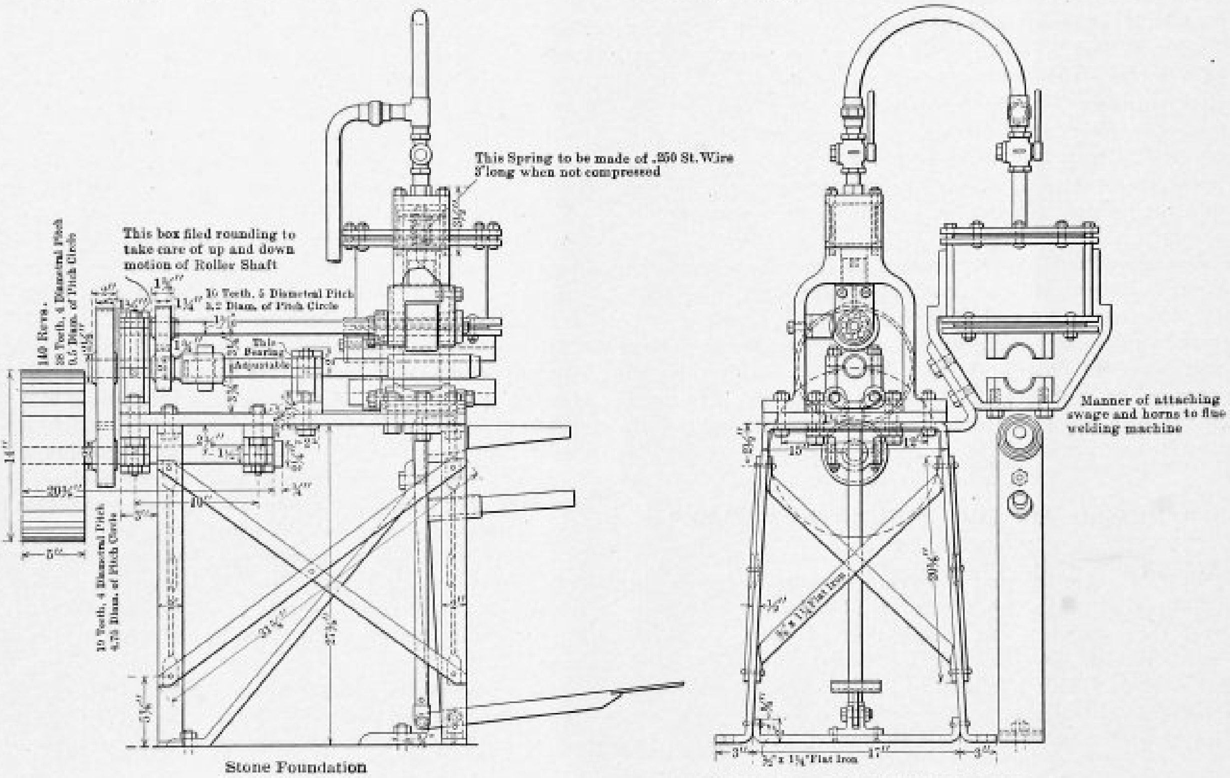


FIG. 1.—FLUE-WELDING MACHINE IN USE AT THE SUNBURY SHOPS OF THE PENNSYLVANIA RAILROAD.

FLUE WELDING.*

BY C. A. SENSENBACH.

Prior to the installation of the present method of welding flues, it had been the practice to perform all the various operations connected with the welding of flues by hand power alone, using coal for heating purposes. The process was slow and expensive, and we were forced by necessity to adopt a method that would give better results. After looking into the subject for some time and experimenting with different appliances which we had seen elsewhere, we finally evolved a machine which we now have in use, and which fills every requirement as we see it.

We believe a drawing of the machine would be better understood than any word description we could give of it, and we have, therefore, prepared a drawing of it, and have attached same to this report. This machine is of home manufacture. We would add that the machine has a detachable roller, which we remove and then attach a metal disc for cutting off safe

* From a report presented before the International Railroad Master Blacksmiths' Association.

We use but one man in welding flues. His output will average thirty to thirty-five flues per hour. The various operations performed by this one man, and considered as a part of the welding process, are: Heat flue, bell-out flue, putting safe end in flue, weld flue and swaging.

The operator is allowed 1 2/10 cents per flue welded, and the furnace consumes aproximately 5 gallons fuel oil per hour.

Flue welding in locomotive repair shops has become a topic of prime importance. Speed in the work and good workmanship are demanded, and to obtain the best results all tools and appliances used in the various operations must be in close proximity to each other. This refers particularly to the location of the rattler, furnace and welding machine. It is also advisable to have a good wagon for use in transporting flues from one locality to another; also to have tools in good condition at all times. Another point, vitally necessary in the economic handling of the entire matter, is to have a thoroughly competent man to handle the work.

No distinction is made at this point between iron or steel flues, nor as to diameter of flues. I notice that some reports we have had in the past on the subject of flue welding state that at some shops it is the practice to scarf or bevel the safe and flue end. We do not follow this practice. We have less than 1 percent of our welded flues leak at the weld. I believe that this showing effectually refutes the necessity of scarfing.

I offer, for your examination, several samples of flues welded as above, and feel confident that the exhibit will substantiate the points we bring forth.

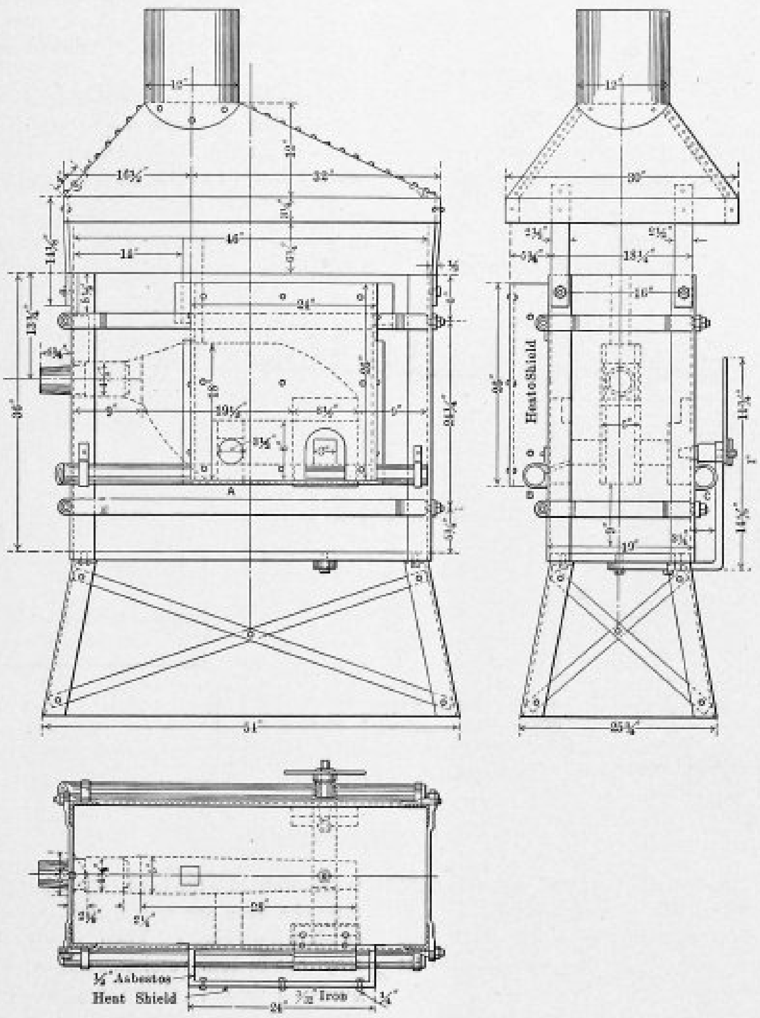


FIG. 2.—FLUE-HEATING FURNACE DESIGNED BY C. A. SENSENBACH.

In conclusion, I would states that what has been said is merely an outline of the practice at one point, and from which good results, in our opinion, have been obtained. If any point has not been made clear, I will be glad to give any further information desired.

Boiler Explosions in 1909.

According to the reports of the Hartford Steam Boiler Inspection & Insurance Company, the total number of boiler explosions for 1909 was 550, which is the greatest number that has been reported in any one year. There were 470 in 1908, 471 in 1907, 431 in 1906, and 450 in 1905. Although the number of explosions was greater this year than ever before, the number of deaths was less than it has been for any year since 1904. The number of persons killed by boiler explosions in 1909 was 227, against 281 in 1908, 300 in 1907, 235 in 1906, 383 in 1905, and 220 in 1904. The number of persons injured but not killed in 1909 was 422, against 531 in 1908, 420 in 1907, 467 in 1906, 585 in 1905, and 394 in 1904.

NOTES ON LOCOMOTIVE BOILER FAILURES.

BY J. N. HELTZEL.

The writer has been very much interested in discussions from time to time about the cause of leaky flues, leaky mudring corners and other troublesome parts of the locomotive boiler. The credit is usually given the workman for all these failures, but I beg to differ from this opinion, and will show that the man who designs the boiler is directly to blame for most of the failures.

Locomotive boilers of recent design are not being worn out by the mileage they make, but instead wear themselves out because the expansion of one part is resisted by another from the time fire is placed in a cold fire-box and a full head of steam raised until cooled down again. It is evident that when a fire is placed in a cold boiler the fire-box plates and flues reach a high degree of temperature, while the outer parts of the boiler are cold. Now, let us see if the wrapper sheet and flues can expand in a horizontal direction without setting up severe strains on other parts of the boiler. These are the actual conditions:

1. The side sheets have a tendency to corrugate in a vertical direction.

2. The front flue sheet may move forward, which will set up a severe strain in the knuckle of the flange.

3. The flues may bend downward and move slightly in the flue holes.

4. The door sheet expands, causing the fire-door flange to crack.

5. When firing a cold boiler the stay-bolts are subjected to a severe diagonal thrust, causing them to fracture, and, consequently, they break when put in tension.

We will now sum up the effect of the five forces mentioned above:

1. Causes cracked side sheets.

2. Causes front flue sheet to crack circumferentially in knuckle of flange.

3. Causes flues to move from their original setting, causing them to leak later.

4. The door sheet expands, causing the flange to crack at the door hole.

5. Causes fractured stay-bolts.

From the foregoing explanation it is evident that we are in need of a design for the inner parts of a boiler that will expand and contract freely, so that one part will not resist the movement of the other. When this is accomplished we will have a fire-box and flue sheet that will be worn out by the mileage and service it gives, and not by the resistance to its natural expansion and contraction.

In connection with the foregoing I cannot help but mention the William H. Wood locomotive fire-box and tube plates. They appeal to me as the ideal fire-box and tube plate for a modern locomotive boiler. Mr. Wood's views on the contraction and expansion of the fire-box and flue sheet are in accord with those of practical men.

EFFICIENCY OF EXPANSION STAYS.

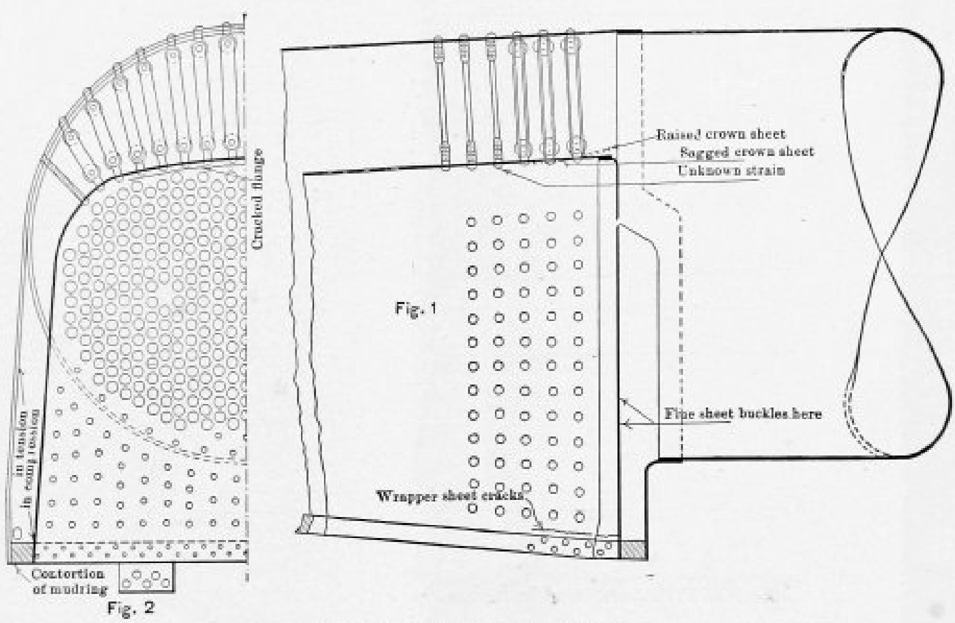
Every brace and stay that enters into the construction of a boiler is so arranged to sustain a certain load. This rated load is determined by the amount of pressure carried on the boiler at a nominal factor of safety, which should be maintained at all times under all conditions. If, for instance, a brace is relieved of its load by some cause, the next brace adjoining will have to carry the burden, or a part at least, if it happened to be between two other braces. Assume that a locomotive boiler is built to carry a certain pressure at a factor of safety of six on all parts and one brace breaks. This would reduce the factor of safety, and will cause other members to fail, and may be the cause of a boiler explosion if not given immediate attention.

It is impossible to compute the strain on the braces in certain parts of a locomotive boiler. For example, take the expansion stays of a consolidation type of locomotive, as shown at Figs. 1 and 2. This is a design of expansion stay extensively used, but is far from being an ideal one, as it fills up with mud and scale between the straps, and when the front row is in compression cannot be detected. I might add that we are badly in need of an expansion stay that will adjust itself to the condition under which the fire-box is working, and that will at all times sustain the load assigned to it.

The writer has designed an expansion stay that he considers will meet the above requirements, and which will be described later.

Referring to Figs. 1 and 2, let us take the upward expansion of the flue and side sheets into consideration. It is a well-known fact that, due to the rolling of the flues, the flue sheet moves upward in this class of engine. This upward movement is facilitated by the heat expansion, and increases slightly every time the flues are rolled until the wrapper sheet is flared out, as shown at Fig. 2. Then, surely, the front row of expansion stays are in compression, even after the boiler has been cooled down. I do not believe that the remaining two rows of stays ever hold very much, but I believe that the burden is carried by the flue sheet and first row of crown bolts. The crown sheet being bent to a radius forms a truss, which is self-sustaining until the sheet becomes hot by low water; then the front part of the crown sheet drops until relieved by the sling stays, which are suspended loose from the roof sheet; therefore, if the expansion stays do not stay the front part of the crown sheet, and the flue sheet has moved upward to the extent that the front row of stays is in compression, the load must concentrate on the mud-ring, throwing the greatest stress on the corners, causing the mud-ring to distort and break. Note the effect these conditions have on the inside sheets and outside sheets by referring to the arrows in Fig. 2. The reader will note that the inside sheet will be in compression and the outside sheet in tension. The effect of these two forces on the mud-ring corners is obvious. It is evident that broken mud-ring corners are not inexplicable.

When the flue sheet has moved upward to a point where it is resisted by the stretching of the crown sheet and front row of expansion stays, the sheet buckles at a point near the lower flues, which strips the beads off the flues. This buckle becomes



EFFECT OF EXPANSION OF FLUE SHEET.

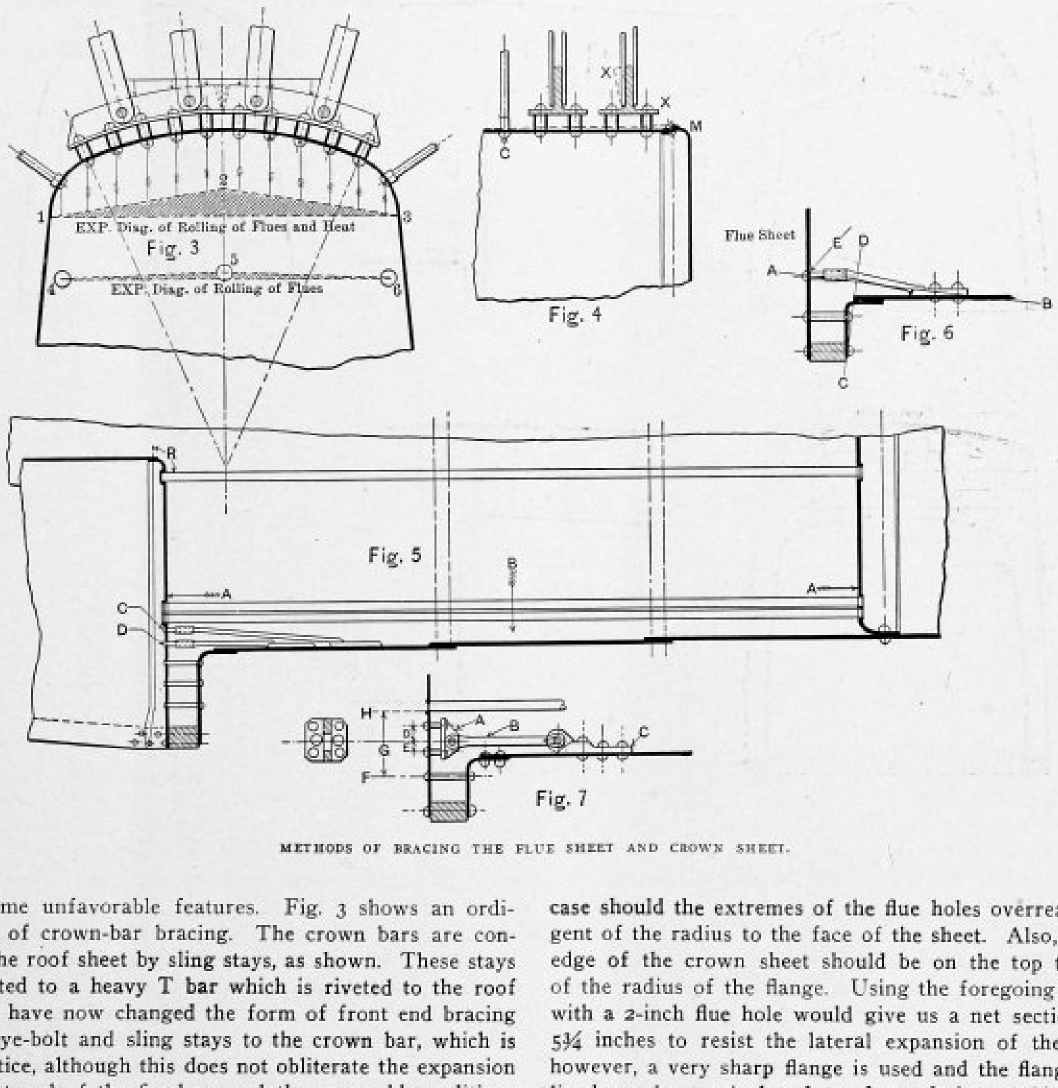
larger every time the flues are rolled, so it is obvious that it is not the pressure back of the sheet that is the sole cause of the sheet bulging.

I also wish to call the reader's attention to the cracking of the wrapper sheet along the top line of the mud-ring at the corners. These cracks are due directly to the twisting of the mud-ring, caused by the fire-box side sheet being in compression and the outside sheet being in tension. After the surface of the plate has been broken chemical action soon takes place, and the crack soon extends through the entire thickness of the plate.

As I dispute the efficiency of the expansion stays I would recommend the use of two or three crown bars as a more feasible form of front end bracing, although this form of bracing has some unfavorable features. Fig. 3 shows an ordinary form of crown-bar bracing. The crown bars are connected to the roof sheet by sling stays, as shown. These stays are connected to a heavy T bar which is riveted to the roof sheet. We have now changed the form of front end bracing from the eye-bolt and sling stays to the crown bar, which is better practice, although this does not obliterate the expansion of the front end of the fire-box, and the same old conditions present themselves, viz.: that the slings are loose and the load is thrown on the flue and side sheets.

It seems to the writer that the crown bar next to the flue sheet is subjected to severe strains, caused by the upward movement of the sheet, referring to the expansion diagram in Fig. 3, which has been based on measurements taken of the expansion of a new flue sheet of a large Pacific type engine. This engine had been equipped with a new fire-box, and the writer was interested in the extent of the upward movement of the flue sheet while new. After all work had been completed and the boiler was ready for flues the writer trammed the flue sheet with fixed solid trams, using fine centers and center marks on the sheet. After the coppers had been rolled and the flues set the trams were again applied, and it was found that the centers had moved upward in the middle of the flue sheet 3/64 inch. After the engine had been fired up once and then cooled off the sheet was again trammed, and it was found that the sheet had moved in a vertical direction 5/64 inch, making an upward movement of the center of ⅛ inch and a lateral movement of 1/16 inch. This lateral movement of the sheet, due to the expanding of the flues, is the cause of the sheet cracking from the flue holes around the flange. To obviate this defect it is good practice to make the distance *R*, Fig. 5, as large as conditions will permit. I would favor a radius of the flange at the top of the sheet equal to one and one-half times the diameter of flue used. And in no case should the extremes of the flue holes overreach the tangent of the radius to the face of the sheet. Also, the calking edge of the crown sheet should be on the top tangent line of the radius of the flange. Using the foregoing dimensions with a 2-inch flue hole would give us a net section of about 5¼ inches to resist the lateral expansion of the sheet. If, however, a very sharp flange is used and the flange holes are lined up about 2 inches from face of sheet, which is usually the case, the direct thrust of flue sheet is brought on the edge of the crown sheet. The thrust of the flue sheet has a tendency to bell the end of the crown sheet, as shown at *M*, Fig. 4, and will displace the front crown bar, as shown at *x-x* in the same figure. The latter is particularly apparent when the front row of bolts is located close to the flange of the flue sheet.

Referring to the expansion diagrams in Fig. 3 it is apparent that the sheet expands most in the center. This has a tendency to bend the front crown bar in the center. This is undoubtedly the cause of crown-bar bolt leakage in the front end of the crown sheet. The Wood's patent tube plate offers a very good



METHODS OF BRACING THE FLUE SHEET AND CROWN SHEET.

solution to obviate the distortion of the front end of the crown sheet, since the upward thrust of the flue sheet is spent in the corrugation.

FLUE SHEET BRACES.

It seems that no rule is adhered to for computing the number of braces to be applied to a flue sheet, but braces are crowded in until the space below the flues is completely filled. I consider this practice radically wrong, and claim that our back flue sheets are too rigidly braced, and that the braces are applied too close to the flues. This is done to keep sheet from bulging, but it only makes conditions worse, because when braces are placed close to the flues the sheet cannot give when the flue expands longitudinally. This causes the flue to sag and become dislocated in the hole, which results in leaky flues. This is the beginning of the leaky flue problem.

If we wish to obviate the leaky flue problem to any degree we must first provide for free expansion of the flues. The remedy, however, lies in the design of the flue sheets, and it seems to the writer is attained in the design of the Wood's tube plates, since in this construction it is evident that the flues will not sag or move from their original setting, as is the case in the flat, rigidly braced sheet, but instead the entire sheet will vibrate in accord with the expansion of flues. It is obvious that flue leakage will be reduced to a minimum in this design of flue sheet.

Broken flue sheet braces are very common in our very large engines where long flues are used, especially with the socket brace, as shown in Fig. 6. The only good feature this brace has is that it is not obstructive, and will not afford a lodging place for mud and scale. Fig. 6 shows an improper position of this brace. For when applied in this position the bolt always breaks at *E*. This is obvious, because when the brace is in tension it has a tendency to straighten through the line *D C*. The broken brace, however, is not due to the pressure in the boiler, but to the thrust due to the longitudinal expansion of the flues. Socket braces should always be applied parallel with the barrel of the boiler, the stud and brace being in the same horizontal plane.

I would suggest the flue sheet brace shown in Fig. 7 as a substitute for the socket brace. The brace in question attains a marked degree of flexibility, and will vibrate in accord with the expansion of flues. For when the flues expand and contract the T-bar *A* acts as a lever; the pin in same acts as a fulcrum. The distance *D*, being somewhat greater than *E*, allows the sheet to give or vibrate in accord with the expansion and contraction of the flues; at the same time the entire load will be sustained by the heavy jaw brace *B* pinned to the heavy lug *C*. This form of brace allows the vibration of the sheet to be graduated in the distance *A*, whereas the solid immovable socket brace, as shown at *C* and *D*, Fig. 5, does not possess any flexibility whatever, and retards the expansion of the flues. It is impossible to determine the tension on brace *C*.

Some of the essential features of the Wood's tube plate will appeal more readily to the reader by comparing the latter design with Fig. 5. The arrows *A*, *A* and *B* indicate the movement of the flues when the boiler is fired and working.

Fig. 8 represents a very good form of construction by using crown bars connected to two heavy *T* irons at the roof sheet by sling stays. The flue sheet flange is shown to be a very large radius at the crown sheet. It is best practice to keep the front crown bar as distant as possible from the flue sheet.

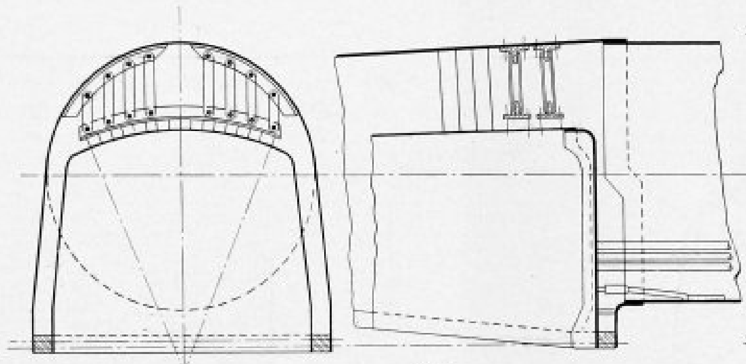


Fig. 8.

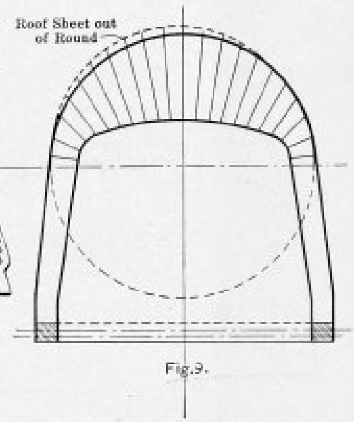


Fig. 9.

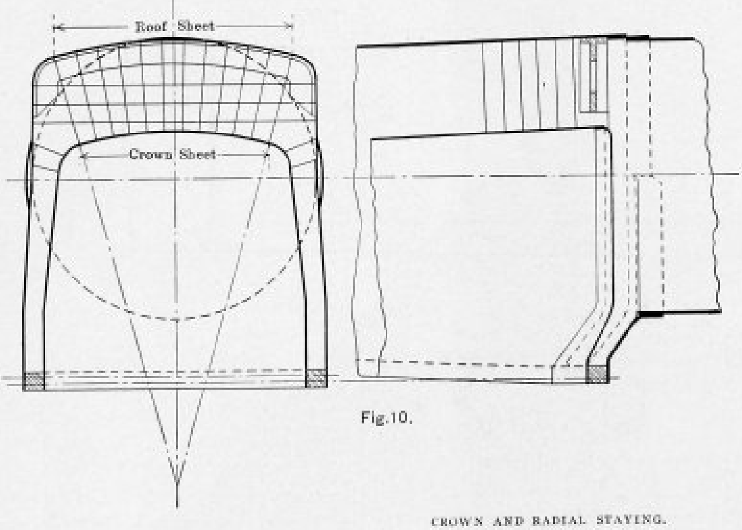


Fig. 10.

CROWN AND RADIAL STAYING.

BROKEN CROWN AND RADIAL STAYS.

The above subject is one which has been discussed from time to time. Some claim that it is useless to apply a hammer test to crown and radial stays. It is true that boilers of the same design and built of the same grade of material vary very much in the number of broken bolts. Comparing two boilers in the two extremes it will be found that the boiler with many broken radial stays involves faulty construction. Referring to Fig. 9, the dotted line at the roof sheet represents the same rolled out of round. The first course of the barrel may also be out of round at this point. It is evident that the plates on the opposite side will be more or less flat. It is a foregone conclusion that if these conditions exist, when the boiler is subjected to a high pressure, the circular portion will have a tendency to form a true circle. Thus it is evident that these conditions will cause the roof sheet to move in a horizontal plane. This causes a constant vibration of the bolts, which causes them to break sooner or later. It is obvious that it is very important to have the boiler plates conform to a true radius when the boiler is built, otherwise it will result in the breaking of crown and radial stays.

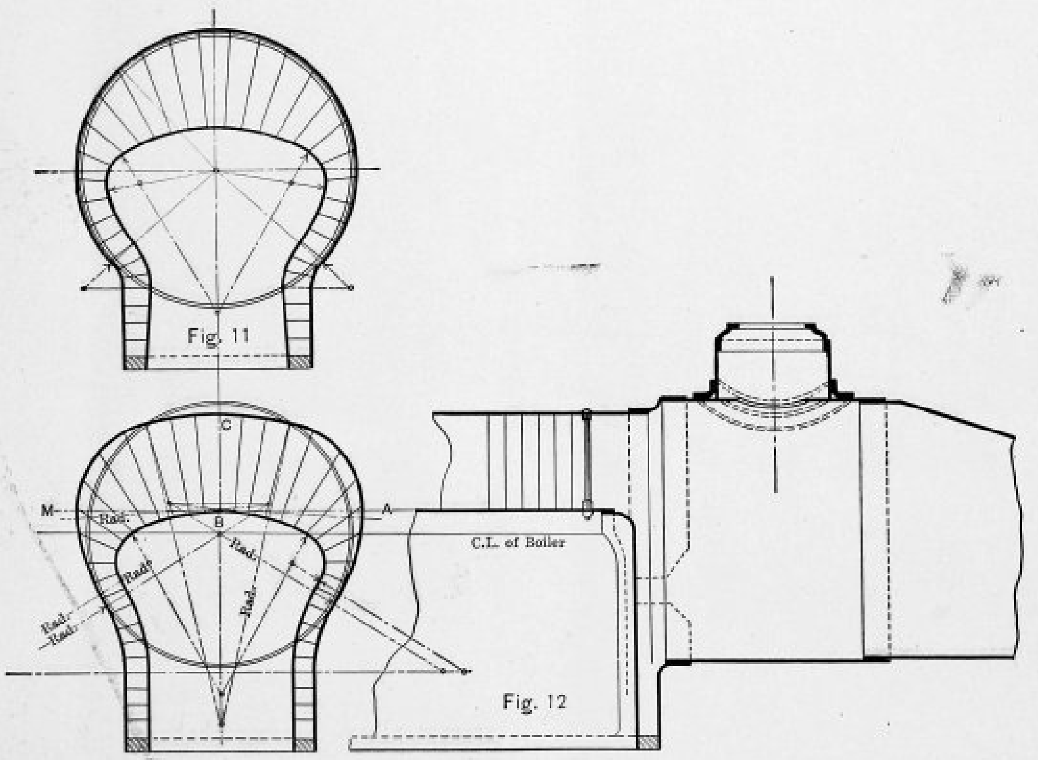
THE BELPAIRE BOILER.

Fig. 10 represents section of a Belpaire boiler. This boiler has some very good features over that of the radial-stayed boiler, or consolidation type, especially in relation to the upward movement of the fire-box. In this boiler the roof sheet is almost flat as well as the crown sheet. The pressure on the roof sheet is greater than pressure on the crown sheet, since the former has a greater area. Then it is evident that the roof sheet will have a tendency to raise the crown sheet and induce an upward movement, which relieves the mud-ring and side sheets from a downward thrust, as is the case with the radial-stayed boiler.

Fig. 11 represents a section of the radial-stayed boiler. This boiler is just opposite to the Belpaire boiler, in that the Belpaire induces an upward movement of the fire-box and the radial-stayed boiler retards the upward movement of the fire-box. This is obvious because the fire-box is enclosed in a circular shell, which will not distort while the boiler is hot while the fire-box expands, and is resisted by the outside shell.

In view of the boilers in the two extremes I submit in Fig. 12 a design of fire-box and wagon top which is neither the Belpaire nor the radial stayed of usual design, but which, however, would be classed with the radial-stayed boiler. By carefully studying the contour of the fire-box and roof sheet it will be plain to the reader that it is possible to construct a radial-stayed boiler that will involve some of the best features contained in the Belpaire boiler. Expansion stays could be dispensed with in the design if a large radius in the flange of the flue sheet at the crown is used. There would be a slight extra cost in the latter design over that of the old-style radial-stayed boiler owing to the high sheet or full throat.

The reader will note by comparing the new design of radial-stayed boiler with that of Fig. 11, that the wagon top of the new design has twice the number of radii that the former has. This is the essential feature in this design.



DESIGN FOR LOCOMOTIVE BOILER, INVOLVING FEATURES OF BOTH BELPAIRE AND RADIAL-STAYED FIRE-BOX.

A NOTABLE SCOTCH BOILER SHOP.

The engineering works of Messrs, David Rowan & Company, Glasgow, Scotland, are of interest not only for their splendid modern and up-to-date equipment, but also for the historical associations which are connected with them. The works occupy the site of the old Lancefield Forge, where the crankshafts of the famous *Great Eastern* were forged, and it was when this ancient leviathan was doing the only useful task she ever performed, namely, laying the first Atlantic cable, that the late Mr. David Rowan established the business which has now grown to such importance.

The first job the young firm turned out included, in addition to a ship's engines, a boiler which was constructed of steel plates, then a great rarity. The ingots for the plates were cast in a foundry in the north part of the city, and were sent to what was then called the Glasgow Iron Company to be rolled. The proprietors of the iron works were so afraid of the new material that they delivered the scrap along with the plates, so determined were they that none of the "evil youngster" should get mixed with the time-honored and respected iron. Of course, they were well advised in exercising such care, yet the incident is interesting as showing how the material, which is to-day commonly used for steam boilers, was regarded forty years ago.

The boiler shop has been entirely rebuilt and extended during the last eight years. All the latest and most powerful appliances that science and experience could devise have been installed, with the result that at the present time the shop is one of the finest in Great Britain. During the reconstruction all the weak points about the workmanship and design of marine boilers were thoroughly investigated, and methods designed to eliminate all defects. Incidentally, the results of these investigations were put into book form for the firm's own use under the title of *Boiler Design and Manufacture*. It has been enlarged and amplified until it forms an invaluable work of reference for their drawing office and works managers. The area of the boiler shop is 57,740 square feet, and consists of four bays, as follows:

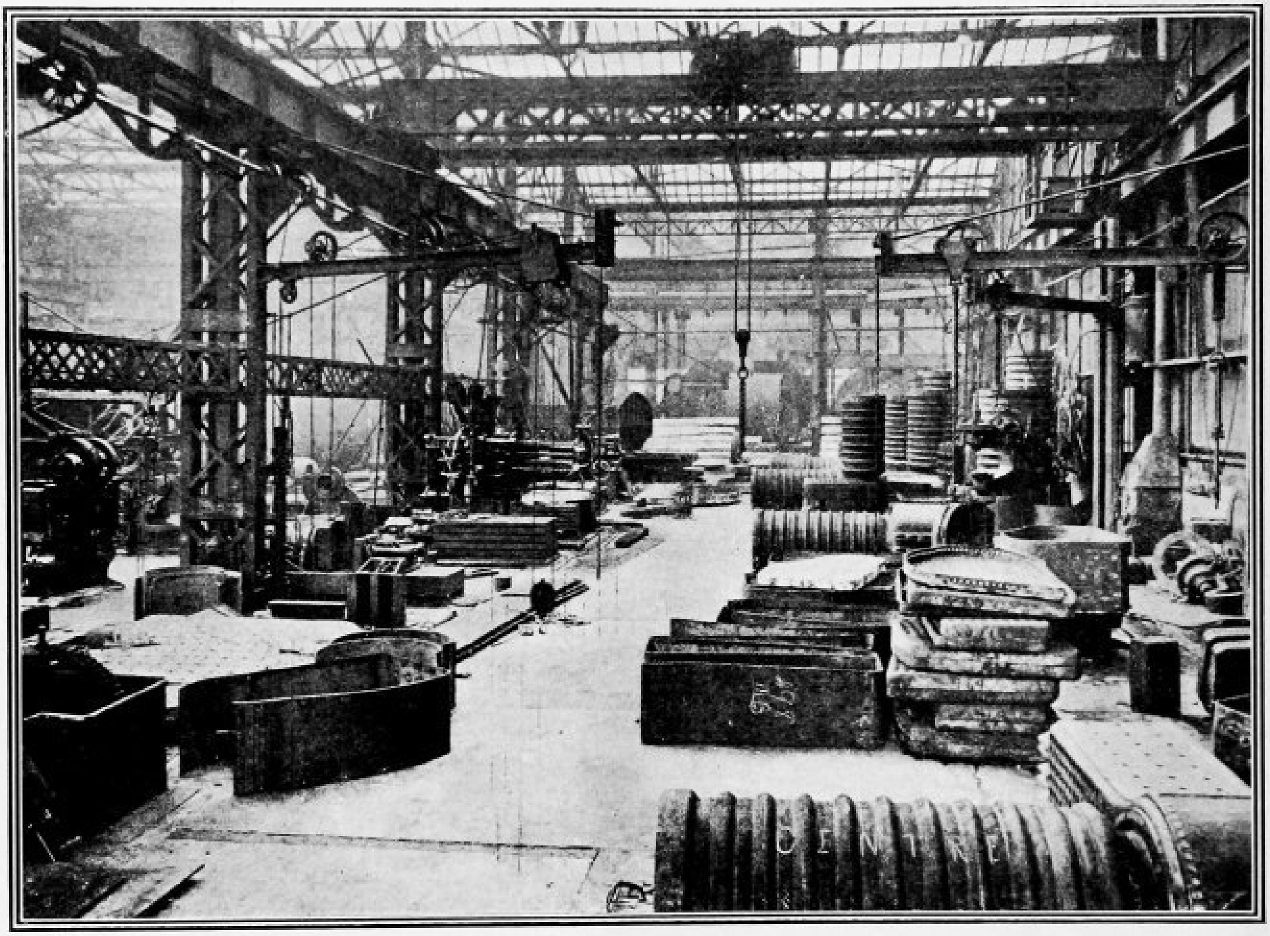
1. The building shop is 238 feet long by 88 feet broad. Area, 20,994 square feet.

2. The flanging shop is 238 feet long by 56 feet broad. Area, 13,328 square feet.

3. The fire-box shop is 190 feet long by 56 feet broad. Area, 9,405 square feet.

4. The light plating shop is 190 feet long by 73¾ feet broad. Area, 14,013 square feet.

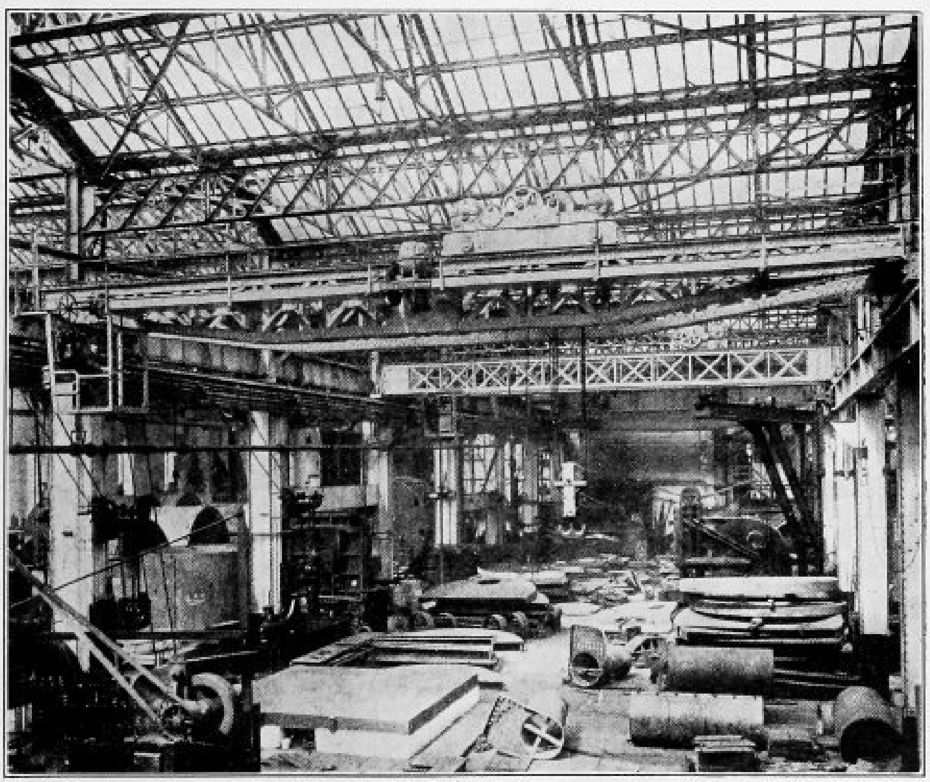
Comprised in the plant in the building bay there are two shell-riveting machines, with gaps of 13 feet 1 inch and 11 feet, respectively. The larger one exerts a pressure on the rivet of any of the four powers, 40 tons, 80 tons, 120 tons, or 160 tons; the pressure of the smaller machine is 60 tons, 80 tons or 100 tons, as may be required. Both machines are fitted with a timing gear, a device whereby the pressure is held on the rivet for a certain stipulated time, and arranged so that it is impossible for the workman to tamper with it. At the end of the period for which it is set the pressure is automatically released. Perfect riveting is thus obtained, as each rivet is thoroughly pressed home, and it is found unnecessary to calk any machine rivet heads. Over the riveting machines there is a well-thought-out gantry, with a separate hydraulic crane for each machine. The working handles for these cranes are placed on the riveting machine platform, so that the machine operator works his own crane. In this shop is also a large shell-bending machine, capable of dealing with plates up to 13 feet broad and 2 inches thick. The shells, with ends in position, are drilled at a very fine new shell-drilling machine, by G. & A. Harvey, which has four drills working at one time, and which was built to Messrs. Rowans' own ideas. This machine gets through its work in a wonderfully quick and efficient manner, with one man only in attendance. A four-armed drilling machine for drilling shell plates on the flat and the stay holes in the boiler ends also forms part of the equipment found here.



FIRE-BOX SHOP. PART OF LIGHT PLATING SHOP TO LEFT.

The plant of the flanging department comprises a small flanging machine, by Fielding & Platt, which deals with all fire-box plate flanging. The end plates are flanged in a large machine, by Hugh Smith & Company. This machine is capable of exerting a pressure of 240 tons, and produces excellent work. The fire-box shop, laid off in 1906, is fitted with drilling machines for combustion chambers and radial drilling

BUILDING AND FLANGING BAYS OF ROWAN'S BOILER SHOP.



FLANGING SHOP.

machines. Two portable riveting machines for fire-boxes are installed in this shop. A very powerful planing machine, capable of taking an ⅛-inch cut off a 2-inch plate, has recently been put down. A set of bending rolls is installed in this department for rolling the plates for plain furnaces and light plates generally. There is also installed a plant for welding plain furnaces, and an annealing furnace for annealing after all local heating is finished.

In the fourth bay, which is also a new shop, are built the funnels, smoke-boxes and casings and other light work, and the equipment here is quite up to the admirable character distinguishing the rest of the plant. In addition to the machines enumerated there are one or two ingenious electric tools used for expanding tubes, tapping stay-tube holes and large stud holes. Compressed air is extensively used for chipping, calking and drilling.

What especially appeals to the visitor is the prevailing order and the cleanliness, the latter due to the floor being laid with granolithic, and the thoroughly organized way in which the work proceeds. The workmanship throughout is of the highest class, and particularly the plating work, the fit of the ends into the shells being remarkably fine. As a matter of fact, Messrs. Rowan attribute much of their success in boiler making to the care they exercise in this work. The furnace holes in the end plates are in every case machined out to the exact size of the furnace, which is drawn into place and makes a perfect fit. In addition to those required by ships engined by themselves, the firm builds a large number of boilers for engineering firms who have no boiler shops of their own, as well as for export. They have sent boilers to such widely-separated countries as Japan, China, South America and Canada. The firm is at present turning out an average of over two boilers a week, and their output for 1908 was 120 marine boilers.

A COMPOUND AIR COMPRESSOR.

The machine herewith illustrated, the capacity of which is rated at 183,640 cubic feet per hour, has the following dimensions:

Diameter of low-pressure air cylinders, 35.4 inches; diameter of high-pressure air cylinders, 22.6 inches; diameter of high-pressure steam cylinders, 22.6 inches; diameter of low-pressure steam cylinders, 35.4 inches; common stroke of all pistons, 43.3 inches.

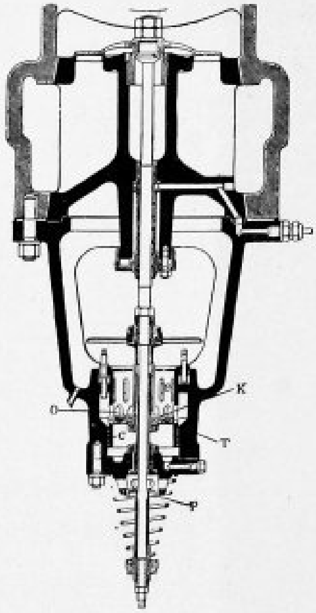


FIG. 2.

The steam pressure at the throttle of the high-pressure cylinder is 170 pounds per square inch, and the air pressure from 88 to 118 pounds per square inch.

The air which is drawn into the low-pressure air cylinder, and there submitted to the preliminary compression, is led through a cooling pipe under the floor to the high-pressure pump cylinder, and in the latter submitted to further compression.

There are no cooling jackets on either of the pump cylinders, and there is also no injection.

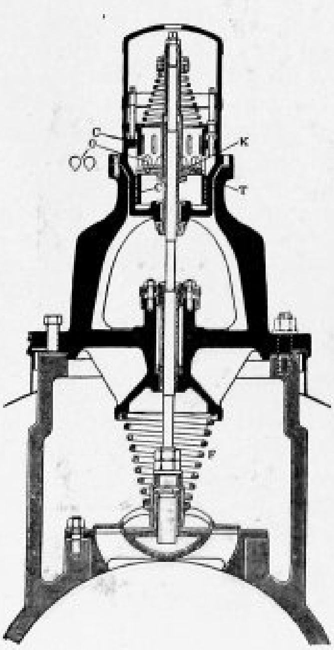


FIG. 1.

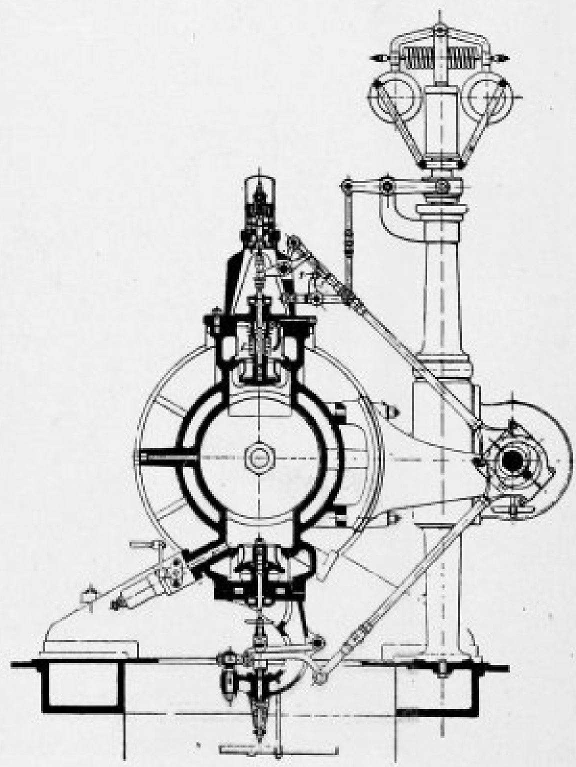


FIG. 3.

The suction and the discharge pump valves, which are of aluminum bronze, are on the Collman principle and automatic. Their closure, hastened by spiral springs *F*, is unhindered until they have nearly reached their seats; when, to prevent slamming, they are slowed up by an oil buffer. The details of the discharge valve are as follows, the valve being shown fully closed:

In connection with the valve spindle is a buffer piston *K*, Fig. 1, which plays in an oil cylinder *C*, and which, nearly to its neck-like end (that is left free to permit of adjustment) is covered by the oil. The circulation of the oil from one side of the piston to the other is by means of passages *O* arranged about the cylinder, and the action of which may be varied so as to regulate the influence of the buffer by turning the cap *H*. It is only during the last small portion of the valve movement that the oil piston has a retarding action. These holes *O* are not round but egg-shaped, with the sharp point below, so that their retarding action is almost ideal.

In the oil piston there is a clap valve *T* which permits ready movement of that piston on the opening stroke. The detail of the suction valves are shown in Fig. 2, and correspond in general principle to those above described of the discharge or pressure valve.

Each air cylinder end has only one suction and one pressure valve. The dead space between the piston and cylinder head is quite small.

The pump is driven, through a prolongation of its piston rod, by a compound steam engine, the admission valves of which also have Collman gear. The closure of these valves, which are opened by eccentric and steel blocks, is effected and regulated in the same way as already described for the pump cylinders.

The cut-off gear of the steam cylinders is shown in Figs. 3 and 4. An eccentric on the cut-off shaft actuates the cut-off rod *a*, and through this the piece *b*, which is free to turn about

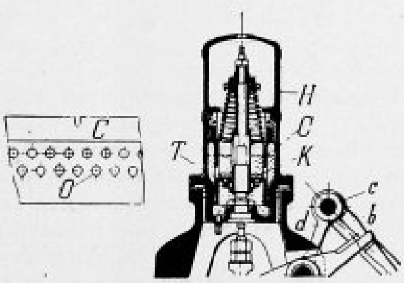


FIG. 4.

the point *c*, that is guided by the rod *d*. The governor acts upon a horizontal shaft *e*, Fig. 3, on which is keyed the lever *f*, that bears on its end a roller. The rotation of the shaft and the resulting engagement release the catch *b* sooner or later, according to the load on the engine, and thus lets the admission valve close correspondingly earlier or later. The rise of the catch *b* is but slight, and the seating occurs directly after the dead point of the cut-off eccentric; *i. e.*, at very low speed and without shock. The engaging edges lap but a few millimeters, so that back action on the governor is out of the question.

In order to attain regular admission in running empty the valve seats have shoulders, a few millimeters deep, as for piston valves, and which permit admission only shortly after the valves have begun to lift.

The admission valve gear of the high-pressure steam cylinder is regulated by a Hartung spring shaft governor. The exhaust valves are actuated by an eccentric and adjustable cams and levers.

The steam cylinders are connected to the crankshaft bearings by a girder frame which has round guides. The steam piston rod, which is prolonged backwards, is connected with the pump piston rod by a coupling shoe which runs on guides. The latter, as well as the cylinders and the rear portion of the girder frame, are bedded on a common foundation plate. Besides this the girder is connected with the air cylinders by two wrought iron struts. The high-pressure steam cylinder is steam-jacketed.

All rubbing surfaces, except the cross-head bearings, are of white metal; the latter, which are of phosphor bronze, are adjustable by wedges. The cross-head end of the connecting rod is forked.

There is lubrication of both the steam and the air cylinders by two positive double oilers with glass drop tubes, and driven by links from the rear end of the gear shaft. Besides this each cylinder has an emergency oiling device. All other lubricators have drop feed, and the crankshaft has the well-known "Buckeye" centrifugal device. The superfluous oil at all bearings is collected in drip pans and returned by suitably arranged piping to a common reservoir.

The builders are Schüchtermann & Kremer, Dortmund, Westphalia, Germany. R. G.

The Best Form of Longitudinal Joint for Boilers.

A paper on the above subject was recently read by Mr. F. W. Dean before the American Society of Mechanical Engineers (see THE BOILER MAKER, Vol. IX., page 325). In discussing this paper, Col. E. D. Meier, president of the American Boiler Manufacturers' Association, had the following to say:

"I think that the value of this joint depends largely on the diameter of the boiler that one has in mind. In a Scotch marine boiler, from 12 to 15 feet in diameter, the joint would be an excellent one, especially with the scalloped edges mentioned by Mr. Dean. That is a very troublesome thing to do, but in addition to the advantage of the scalloped edge which Mr. Dean cited, there is the further one, that it modifies the tendency, common to such joints, to buckle at the point where the sheets come together. The butt joint is stiffer there than any other part of the shell, and with a change in the pressure and temperature the buckling ultimately tends to impair the joint.

With a small boiler, 36, 42, or 48 inches in diameter, the joint is too large a proportion of the total circumference, and this action would become worse. That buckling action is distributed by making butt plates as thin as possible, and making the inside one longer than the outside one.

The one joint that was not considered in the paper—the welded joint—will be an ideal one when we can be sure of a weld that will give 95 percent efficiency. The difficulty will be to test it. We do know, however, that when we rivet a joint and do it honestly, we have something that can be relied on. Much will depend on how the material is chosen and how the work of laying up and riveting is done. The joint should be made by carefully bending the butt straps at a red heat to the true curve, and rolling the plate itself true to template. This will make as perfect a joint as possible. For a large diameter of boiler, I think the joint advocated by Mr. Dean, especially if the edges are scalloped, is an excellent one, but for smaller diameters I prefer the old joint.

Two other points must be considered: First, how the calking is done, as in many sheets the initial fracture is caused by bad calking; second, what sort of metal was used, for unless the chemical analysis of the plates as to minimum of injurious metalloids is firmly insisted on, trouble is sure to follow even in the best proportioned points."

THE EFFECT OF SUPERHEATED STEAM ON CAST IRON AND STEEL.*

The Effect of Superheated Steam on the Strength of Cast Iron, Gun Iron and Steel.

BY EDWARD F. MILLER.

The object of this paper is to describe some experiments made to determine the effect of superheated steam on cast iron, gun iron and steel. From each piece to be tested two tension specimens were made, one to be subjected to the action of superheated steam, and one to be used in obtaining the original strength of the piece.

All of the specimens were made with screwed ends in accordance with the specification prepared by the American Society for Testing Materials. The tension tests were made

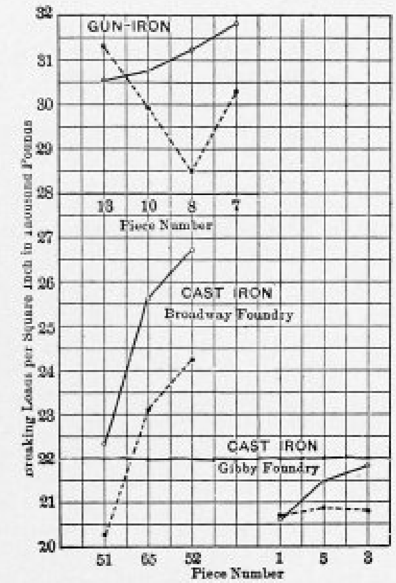


FIG. 1.—BREAKING LOADS OF GUN IRON AND CAST IRON TEST PIECES SUBJECTED TO THE ACTION OF SUPERHEATED STEAM.

on a 100,000-pound Olsen testing machine, the specimens being screwed into spherical holders attached to the heads of the testing machine, thus ensuring a straight tension pull without any bending.

The specimens to be subjected to superheat were placed on a wire grating suspended at the center of a 12-inch iron pipe about 3 feet long, supported horizontally on brackets. The ends were closed by blank flanges. Steam was supplied by a small pipe, a flow at low velocity being maintained at all times. The under side of the pipe was heated by Bunsen gas burners. Thermometers, in wells reaching down to the grating on which the specimens were placed, gave the temperature of the steam, the pressure being read from a steam gage on the supply pipe.

For the tests plotted in Fig. 1, the average gage pressure in the superheating pipe was 93 pounds, and the average temperature 660 degrees F. The gas flame was extinguished at 5 P. M. and lighted again at 7 A. M. The temperature reached 660 degrees F. by 11 A. M., and by 5 P. M. would be as high as 700 or 720 degrees. Steam was kept in the superheater during the night. The total time these specimens were exposed to superheated steam was 260 hours, and the exposure to saturated steam was 460 hours. A chemical anaylsis of the iron tested is given in Table 1.

* From papers presented before the American Society of Mechanical Engineers.

TABLE 1.—CHEMICAL ANALYSIS OF CAST IRON SPECIMENS, FIG. 1.

	Phosphorus.	Total Carbon.	Graphitic Carbon.	Manganese.	Silicon	Sulphur.
Cast iron Gibby Fdry. .		3.51	3.02	0.37	1.88	0.05
Gun iron Hunt Spiller.	0.41	3.25	2.60	0.24	0.54	0.09
Cast iron Broadway Foundry.		3.[illegible]4	2.84	0.38	2.26	0.09

For the tests plotted in Fig. 2 the average gage pressure was 82 pounds, and the average amount of superheat about 390 degrees F. These specimens were subjected to superheated steam for 520 hours, and to saturated steam for 920 hours. A chemical analysis of three of the semi-steel specimens is given in Table 2. This semi-steel was made by adding 200 pounds of steel to 1,500 pounds of cast iron. The analysis of the gun-iron showed: total carbon, 3.37; graphite, 2.44; manganese, 0.34; sulphur, 0.11; silicon, 1.65.

The composition of two of the rolled-steel pieces, No. 26 and No. 27, was as follows:

	Phosphorus.	Total Carbon.	Manganese.	Sulphur.	Silicon.
No. 26	0.85	. . . .	0.73	0.026	0.026
No. 27	0.116	. . . .	0.90	[illegible]	0.031

In Fig. 1 and Fig. 2 the open circles represent the ultimate strength per square inch of the original specimen, while a full circle on the same ordinate gives the strength per square inch of the comparison specimen which had been subjected to the action of superheated steam. By figuring the percent loss in

TABLE 2.—CHEMICAL ANALYSIS OF SEMI-STEEL SPECIMENS, FIG. 2.

Phosphorus.	Total Carbon.	Graphite.	Manganese.	Sulphur.	Silicon.
. . . .	. . . .	2.64	. . . .	0.11	. . . .
0.24	3.48	2.39	0.35	0.11	1.91
0.61	3.22	2.83	0.44	0.49	2.62

strength in each specimen and then taking the average of these percents, it appears that the cast iron from the Broadway Foundry (Fig. 1) lost 9.5 percent; that of the Gibby Foundry 2.4 percent. The cast iron of Fig. 2 came from the Waltham Foundry; here there is aparently a gain in strength of 1.8 percent. Fig. 1 and Fig. 2 show that gun-iron loses strength, Fig. 1 showing a loss of about 3.5 percent, and Fig. 2 about 2.1 percent.

The tests on semi-steel show an average reduction of strength due to exposure to the steam, of about 0.4 percent, four out of six pieces showing quite a reduction. If piece No. 154 is not considered, the percentage reduction of strength would be much greater.

Four grades of steel were tested; two pieces from a bar of 65,000 to 70,000-pound tensile strength, two from a bar of 75,000 to 80,000-pound tensile strength, two each from three bars of about 90,000-pound tensile strength, and two from a bar of over 100,000-pound tensile strength. The 65,000 to 70,000-pound steel showed a loss of 1.8 percent, due to exposure to the steam, the 75,000 to 80,000-pound steel a loss of 1.9 percent, the 90,000-pound steel a loss of 1.5 percent, and the 100,000-pound a loss of 24 percent.

While one is not justified in drawing many conclusions from the results of as few tests as are quoted here, still it is evident from Fig. 1 and Fig. 2 that the metals tested have suffered a loss in strength due to their exposure to the steam. A paper bearing on this subject, "Materials for the Control of Superheated Steam," by M. W. Kellogg, appeared in the 1907 *Transactions* of the society. In the *Valve World*, March, 1908, are given the results of tests on cast iron taken from the body of a 14-inch valve which had been in use for four years on a main carrying steam at 200 pounds pressure and superheated to a temperature of 590 degrees F. A number of test bars cut from the body of the valve showed a loss of strength of 41 percent when compared with the strength of the original metal, as determined from coupons tested at the time the valve was made.

It is known that cast iron will grow with repeated heatings and coolings, often observed in the ordinary straight grate bar. When the bar is first heated it expands and cools as it contracts; but if the temperature has been high, the bar will increase in length. With a second heating, a further increase takes place, followed by many others. As a consequence the long, single, straight, flat grate warps, and proves the wisdom

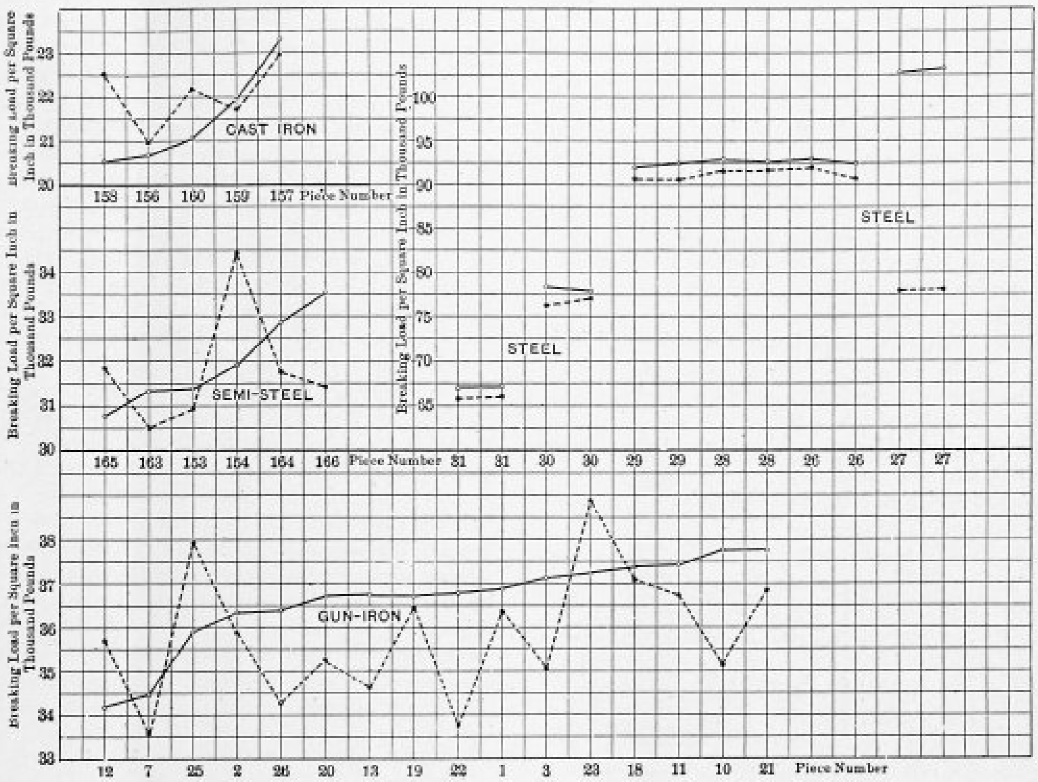


FIG. 2.—BREAKING LOADS OF GUN IRON, SEMI-STEEL AND CAST IRON TEST PIECES SUBJECTED TO THE ACTION OF SUPERHEATED STEAM.

Cast Iron Valves and Fittings for Superheated Steam.

BY ARTHUR S. MANN.

There have been many failures of cast iron valves and fittings in piping systems carrying steam of high pressure and high superheat. The ordinary extra heavy flanged cast iron fittings which are listed in many manufacturers' catalogues as suitable for 200 pounds pressure, and which have to meet a close price competition, have successfully carried a pressure perhaps as high as 150 pounds or more. No doubt the fittings and valves can support a steady pressure of 200 pounds without bursting, but there have been many failures when carrying superheated steam of lower pressure.

These fittings are not too well suited for permanent work of even 150 pounds pressure, and many engineers in control of such matters in stations of a representative type prefer to design their own parts rather than to trust the usual run of commercial extra heavy fittings.

Probably on account of the advertised ability to support a high, steady pressure these extra heavy fittings and valves have been used in a number of instances for superheated work. After a short time, six months or even less perhaps, cracks make their appearance; valves leak, seats become loose, castings grow in length and surface cracks become so large in size and in number that the casting is removed from the line.

A few repetitions of this experience seem to justify the conclusion that cast iron is not fit material for high-temperature steam. The natural substitute is steel, which is used with fair, even complete, success in many cases.

of McClave's rule, "Keep your long lines of metal away from the fire."

This subject of growth has been treated very completely by Outerbridge in his excellent paper published in the *Journal* of the Franklin Institute for February, 1904. Mr. Outerbridge heated his samples to redness, or above, temperatures greatly exceeding that to which a steam pipe fitting is subjected.

A rough experiment on this line was tried by the writer with two samples, one of an ordinary cast iron and a second of a high-grade cast iron, which has proved itself capable of carrying superheated steam and of which a detailed analysis is given in the following pages of this paper. The two samples were each 6 inches long and 1 inch in diameter. They were placed in a banked fire over night, reaching a dull red heat and were allowed to cool in the air. A slight growth, as measured by micrometer, was found in each piece.

This treatment was followed for two or three nights and the growths were measured. There was an increase in the length of each of the samples, the high-grade iron having increased in length slightly more than did the ordinary iron. The experiment so far as it went tended to show that the growth of cast iron does not necesarily unfit it for the usual degree of superheat in power-house work.

Many grades of brass will crumble when heated in a forge to a barely visible red, and are quite unfitted to support any stress at such a temperature. But this characteristic in no way unfits very ordinary cast brass for saturated steam work, and one should not hesitate to use a valve of cast brass up to 3 inches in diameter for 150 pounds saturated steam pressure.

Three inches is not usually exceeded because values of large brass bodies are expensive.

Articles have appeared in various publications showing the disability of cast iron, tensile tests being made before and after the use of fittings of ordinary iron. Cases of bronze seats dropping from valves were cited, and it was not difficult to prove that something better than ordinary cast iron was needed for steam of 180 pounds pressure and 250 degrees superheat. These failures came from two causes. In the first place the iron itself was not of sufficiently good quality; and, secondly, the parts were not thick enough. The static stress probably did not exceed 1,000 pounds in the body; but static stress is not the important load which fittings have to support.

Stresses from expansion and contraction within and without the casting and stresses from pulling up joints no doubt greatly exceed the static load even in pipe very carefully erected. The troubles are aggravated by the action of the steam itself, but it is yet to be proved that the steam or its high temperature will of itself start cracks in a properly designed fitting.

The ordinary commercial extra heavy flanged tee, 8 inches inside diameter, has a body ⅞ inch and flanges 1⅝ inches thick. It is made of common iron, having a tensile strength of about 18,000 pounds. Such a fitting will fail with superheated steam at 175 pounds pressure and 200 degrees superheat. Within a year the inner surfaces will have a network of cracks, some of which will increase in depth till they extend

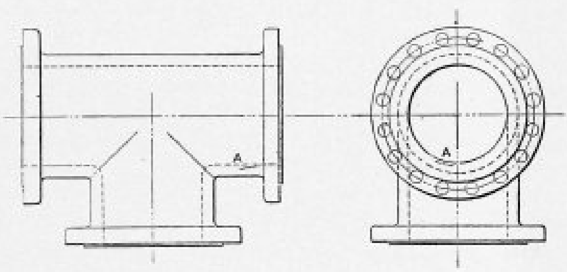


FIG. 3.—A 10-INCH STEEL FITTING, THE IRREGULAR LINE AT A SHOWING THE POINT OF FAILURE UNDER SUPERHEATED STEAM SERVICE.

through the body. The flanges will crack outward from the bolt holes and the fitting will become not only leaky but dangerous as well. The writer has observed just such castings, an analysis of some of them being given later in this paper. Similar effects have been experienced by a great many steam users. The fittings are inherently weak to begin with, so that the failures do not prove that a heavier fitting of better iron is unsuited for superheated steam work.

Within the experience of the writer steel fittings have failed with superheated steam. Out of twenty-five steel gate valves, 6, 8 and 10 inches in diameter, not more than four were fairly tight after one year's service, the bodies themselves yielding enough to leak badly. Some defects in the castings developed, allowing steam to pass straight through the walls when they left the foundry. Some of these defects were such that the fittings and valves could not be repaired. In some cases seats were scraped in once or twice and holes were plugged up or patched, but the material would not have been satisfactory without this working over. Yet all these castings were heavy, materially thicker than the commercially extra heavy cast iron product, and had passed a rigid inspection.

Fig. 3 shows a 10-inch steel fitting; the irregular line at *A* showing a defect developed after use. The line does not pass clear through the casting, and no doubt the piece was amply strong to resist rupture even after the fault developed. Some of these fissures went 3 inches back and were 5 inches broad. Such a large opening in a shell is objectionable, for there are blow-holes enough adjacent to it to pass steam in large quantities. Some fittings of this kind were removed from the line entirely, while others were plugged or patched.

No doubt a thoroughly sound steel casting is able to withstand highly superheated steam. There are several connected to the system under discussion. So far as it has been possible to observe, superheated steam does not of itself initiate defects, and it is not supposed that the sound metal undergoes a change, either chemically or structurally. But if there is an initial defect, superheated steam is much more active in bringing out the objectionable features of that defect. It may well be that the material within the body, and not a part of the actual metal, suffers through change of some sort. This material does not add to the strength of a casting, but it may serve to stop up holes if allowed to lie undisturbed.

It would appear that some material better than the ordinary steel casting was desirable for high-temperature work. Such a material is found in gun-iron. Gun-iron is nothing more than a high-grade cast iron, which any first-class iron foundry can produce. In the days of the smooth-bore cannon, a few foundries discovered that it was possible to produce an iron having a tensile strength of 30,000 pounds or more. The Government specified it for its guns, and it was called gun-iron. Probably a tensile strength of 30,000 pounds is not needed in steam fittings, but iron of that quality is well adapted for 180 pounds steam with 300 degrees superheat.

From such observations as have been thus far possible it appears that certain elements in the iron are liable to cause trouble when present in excess, and perhaps the worst of these is silicon. It is at present going too far to say that every high silicon iron will fail and that every low silicon iron will prove successful, but there is much evidence pointing toward the correctness of such a surmise. In any event iron of low silicon, low phosphorus and low carbon—in other words, gun-iron—has proved successful.

The following analysis shows the character of a casting which failed at 250 degrees superheat:

	Percent.		Percent.
Silicon	2.40	Manganese	0.52
Sulphur	0.067	Total carbon	3.19
Phosphorus	0.94	Combined carbon	0.25

A second failure developed in this iron:

	Percent.		Percent.
Silicon	1.98	Manganese	0.42
Sulphur	0.068	Total carbon	3.31
Phosphorus	0.65	Combined carbon	0.24

In each of these cases a sample was taken by drilling a hole straight into the body after the part had been in service a year or more and was in bad condition.

The following analysis is of an iron that has been successful in every respect for four years under 300 degrees superheat:

	Percent.		Percent.
Silicon	1.72	Manganese	0.48
Sulphur	0.085	Total carbon	2.45
Phosphorus	0.89	Combined carbon	0.17

The latter sample is from an 8-inch valve, and it is tight to-day, no repairs whatever having been made upon the valve during the four years, though the bonnet was taken off once to permit internal examination. The outer surface of the valve was covered with 85 percent magnesia insulation, 4½ inches thick. The inner surface appeared sound; a microscope revealed no cracks or other defects. The unfinished surfaces were struck several sharp blows with a ball-peen hammer, a hand chisel was driven straight at the surface, and some thick chips were cut off from the rough portion. If the metal had suffered to such an extent as cast iron is supposed to suffer, some of the defects would have made themselves manifest. After these treatments the valve was reassembled, and has continued to perform its work properly.

Foundrymen are not afraid to attempt to produce this iron. No difficulty whatever was encountered in securing bids for valves made of the following mixture:

Silicon	1.40 percent to 1.60 percent.
Phosphorus	0.20 percent to 0.40 percent.
Sulphur	0.06 percent to 0.09 percent.
Manganese	0.45 percent to 0.75 percent.
Total carbon...........	3.00 percent to 3.25 percent.

It will be noted that the percentages of silicon and phosphorus are low.

There is, of course, a decided advantage in depending upon chemical analysis for determining the suitability of fittings. A hole can be drilled at any time in the actual fitting and a few grams of sample secured. Very few of us are willing to destroy a fitting to obtain a test bar, and test coupons cast in the foundry may or may not represent the actual piece.

Superheated steam was in commercial use in Europe before the practice had gained its present hold here. England and Germany were using superheated steam twenty or more years ago. The writer has not discussed this subject with engineers from abroad, but wishes to quote briefly those who have.

E. D. Dickinson, of Schenectady, on a recent trip abroad asked a great many manufacturers whether they used steel for their superheated work, and received a negative reply in each instance. When the manufacturer was questioned in regard to his iron mixture, he shrugged his shoulders and replied that he made his iron fit his needs, be it gas-engine cylinder or steam pipe.

John Primrose, in *Power and the Engineer* for June 8, 1909, states that he discussed the matter with English and German engineers. In one instance a well-known German engineer, who had used superheat for twenty-five years, was surprised that he had not learned of the effect of superheated steam upon cast iron. The engineer promised to investigate the matter in Germany, but he could find nothing to bear out the contention, and could find no one who believed that such a thing was possible.

It is not the author's intention to state that steel of good quality will not do for superheated work. Some manufacturers are putting out fittings of open-hearth steel which are doubtless good; but any foundry can make gun-iron if it will, and delay and uncertainty will be decreased by its use.

Cast Iron Fittings for Superheated Steam.

BY PROFESSOR IRA M. HOLLIS.

The failure of a number of large cast iron fittings in use with superheated steam has rightly created a widespread suspicion of this material when exposed to high temperature, yet on this subject there is very little informtaion of a character to justify the wholesale substitution of steel castings for the ordinary heavy cast iron fittings. The latter have been used with success for many years at all degrees of temperature below redness, and in many stations now in operation with moderate degrees of superheating, say 100 degrees Fahrenheit, cast iron has never given the slightest trouble beyond the ordinary wear and tear.

The doubt as to the reliability of cast iron has seemed to spring up with its use in long pipe lines to steam turbines, where the temperature has ranged from 560 to 600 degrees. This would lead one to ask if the difficulty has not been in the design of the piping systems rather than in the character of the material. Has not the cast iron taken the brunt of the new service, and has it not suffered in the estimation of the engineering public because the conditions of that service were not fully understood?

A vast amount of experiment and investigation would be required for a satisfactory reply to this question, and this brief paper is not intended as a reply, but rather to make public a record of some tests that may throw light on the subject. These tests were made for the Edison Illuminating Company, of Boston, for the purpose of determining the bursting strength under hydraulic pressure of some large fittings which were replaced with steel castings.

The new part of the Edison station is arranged in a series of complete units, each consisting of one vertical Curtis turbine and eight boilers set in pairs. The main steam line extends along the rear ends of the boilers just beneath the brick work, four 8-inch vertical steam mains connecting each pair of boilers with the main line. Three of the vertical mains discharge through gate valves into T's, and the fourth at the end of the line through a gate valve into a bend.

The first turbine units were provided throughout with cast iron fittings, which were ultimately replaced with steel fittings. No expansion or slip joints are used. The main steam line, over 103 feet long, is anchored at the turbine end and is allowed to expand freely in a longitudinal or horizontal direction, carrying the lower ends of the vertical mains with it. The steam pressure is 175 pounds, the superheating generally amounts to 150 degrees Fahrenheit; although it is not constant; the actual temperature of the steam varies from 500 to 580 degrees, so that the main line is changing in length from time to time, thus moving the lower ends of the vertical mains back and forth. A series of variable stresses are consequently introduced into all parts of the pipe system, probably affecting more seriously the T's. It is this aspect of the case, namely: the effect of varying stresses upon cast iron at high temperature, that must be studied before a sound verdict can be reached.

When the castings were first suspected of failure, one of them was taken out, and pieces cut from it were tested for tensile strength. Absolutely no proof was found that the material had deteriorated, but it was fully recognized that, although these tests might show that the material had not suffered in service, nevertheless parts of the casting might have been weakened by the expansion stresses, and, for the purposes of testing this, two Ts were removed from the line and broken by internal hydraulic pressure, thus affording a definite idea of the strength of the castings as a whole. A third casting, an L not previously in use, was added for comparison.

The first T broke at an internal pressure of 1,650 pounds per square inch; the second one broke in precisely the same manner at an internal pressure of 3,100 pounds per square inch; the third fitting first withstood a pressure of 2,000 pounds per square inch, and was subsequently broken at a pressure of 1,500 pounds per square inch.

In general the tests did not seem to indicate weakness or deterioration in the cast iron fittings, but under such conditions as prevailed in this case, it was and generally would be wise to replace the cast iron Ts with cast steel, which would yield more readily to expansion, and which would be safer at much higher tensile stresses. The reason for the substitution ought not to be lost sight of in this case, if cast iron is to be judged fairly, because it is cheaper on the whole to replace the cast iron with steel rather than put in expansion or slip joints. Perhaps the steel casting is also much easier to take care of than any form of expansion joint. The unreliability of cast iron in such a service has nothing to do with the case. It is merely that the design usually adopted for steam piping does not quite fit cast iron.

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Electric Drive in the Boiler Shop.

All boiler manufacturers who contemplate building a new plant, or enlarging their present facilities, should read carefully the articles published in our February and current issues on the powering of boiler shops. These articles are intended to show not only wherein economy may be expected by the application of electric drive to boiler shop tools, but also to point out in a general way the requirements of this service, and the best types of motors to use.

Electric drive has become so general in industrial plants of various kinds that a large amount of data are available concerning its application. It is a problem which has passed through the hands of experts, and, as a result, certain lines of equipment have been developed which are more or less standard and reliable.

The question of whether the older method of powering the shop by steam engines driving the machinery through mechanical means should be used, or the newer method of generating electricity and driving each machine by a separate motor or groups of machines by a single motor, cannot be settled off-hand, but, in general, the fact should be realized that in a direct mechanical drive practically one-third of the power developed by the power plant is absorbed in transmission, so that only 66 2/3 percent of the power developed is applied to useful work at the tools, and this proportion holds good for nearly all powers. That is, if the plant is running under a light load the percentage of loss is just as great as when running under a heavy load. With the electric drive, however, a higher percentage of efficiency can be obtained, and this varies with the load factor. At half or three-quarters load the electric drive gives an efficiency sometimes as high as 85 percent, and it is frequently the case that the average load factor in a boiler shop is about 50 percent. Consequently, the electric drive minimizes the waste of power in transmission.

The usual advantages claimed for electric drive by manufacturers of electric motors and other apparatus are decreased cost of operation and decreased cost of equipment. This, however, does not always prove to be the case and, even if it should, it does not show the entire saving which is gained by the use of electric drive. The author of the articles to which we have referred points out that electric equipment may cost more at first and may even cost more to operate, but, due to the fact that more work is turned out in a given time, the total unit cost of production is reduced, and, therefore, more economical and efficient output is the result. Of course, a great deal depends upon the careful layout and design of the power plant, with reference to the present needs and the possibilities of future expansion in order to get economical and efficient results with this kind of power.

Aside from the direct advantages and disadvantages, the value of which can be reckoned exactly in dollars and cents, there are other things of a practical nature to consider which have a bearing on the kind of power transmission that shall be used in a shop. We know of at least one case, where in a new shop electric drive was repudiated on the ground that the workmen employed in the shop did not understand how to operate electrical machinery, and that, consequently, they would burn out the motors and cause needless trouble through ignorance, carelessness, etc. Although this might seem to be a trifling objection, yet it is one which carries weight with practical men. It should be remembered, however, that the class of labor employed in a modern boiler shop is quite different from that employed in shops twenty-five and thirty years ago, and to-day there is no reason why, with the average class of skilled workmen which now forms the greater part of the force in a boiler shop, the men are not, as a rule, quite competent to handle electric machinery in a safe and trustworthy manner.

Other points to which perhaps no exact value can be attached are such questions as cleanliness, convenience of placing machines with reference to the best location for performing the work regardless of the location of the source of power, increased safety and freedom from accidents to employees, due to the elimination of large belts, loose pulleys, etc., besides economy of floor space, more light and less noise. All these are questions which in a measure affect the production of the shop, sometimes to a very large extent, and they should be carefully considered by the manufacturer.

Exhibit of Boiler Makers' Tools.

In connection with the fourth annual convention of the International Master Boiler Makers' Association, to be held at the Clifton Hotel, Niagara Falls, Ontario, Canada, May 24, 25, 26, and 27, the Supply Men are planning to hold an unusual exhibit of tools and machinery. Suitable space and electric power will be available at the hotel, so that machine tools can be exhibited in operation. Inquiries should be addressed to Geo. Slate, THE BOILER MAKER, 17 Battery Place, New York.

Specifications for Steel Boiler Tubes and Safe Ends.

The Pennsylvania Railroad has recently issued new specifications for steel boiler tubes and safe ends, which are as follows:

1. This specification covers cold and hot-drawn and lap welded steel tubes and safe ends. The material must be open-hearth steel. Tubes containing more than .03 percent phosphorus or more than .04 percent sulphur will be rejected.

2. Tubes will be ordered in lots of 100 or multiples thereof, and for each 100 ordered 101 must be furnished. Safe-end material will be ordered as the demands of the service require, and for each 1,000 feet or fraction thereof ordered, two extra feet must be furnished free for test. In ordering, the outside diameter and thickness must be specified, as per table of weights in section 5 of this specification. Safe-end material will be subjected to the same conditions of marking, inspecting and testing as govern boiler tubes.

3. Before shipping, each seamless tube must be subjected by the manufacturer to an internal hydrostatic pressure of 1,000 pounds per square inch, and lap welded tubes must be subjected to an internal hydrostatic pressure of 750 pounds per square inch. Each seamless tube must be plainly marked in the middle: "Seamless Steel Tested to 1,000 Pounds Pressure," with the manufacturer's name. Lap welded tubes must be marked: "Lap Welded Steel Tested to 750 Pounds Pressure," with the manufacturer's name.

4. On receipt at the shops, the tubes will be inspected for surface defects. They must have a smooth surface and be free from cracks, blisters, laminations or pits, both internally and externally, and must also be free from kinks, bends, buckles or evidence of injury during manufacture. Seamless tubes must be of uniform thickness throughout, and must be round within .020 inch, the mean diameter and thickness being within .010 inch of the size ordered. Lap welded tubes must be within .01 inch of the thickness specified except at the weld, where .015 inch additional will be allowed. They must be round within .02 inch, and the mean diameter must be within .015 inch of the size ordered. Tubes must not be less than the length ordered, but may exceed it by .125 inch.

5. The minimum weights of various diameters and thicknesses, which will be accepted, are as shown in the table.

6. On receipt at the shops, the tubes will be piled in lots of 101 and safe ends in lots of 1,000 feet. Each lot will be tagged with the requisition number, lot number and name of manufacturer; one lot to be used for each 101 tubes, and one lot for each 1,000 feet of safe-end material, thus:

Requisition 3,792—Lot 1, name of manufacturer; lot 2, name of manufacturer; lot 3, name of manufacturer; lot 4, name of manufacturer; lot 5, name of manufacturer.

This to mean that there were 500 tubes, or 5,000 feet of safe-end material ordered from one manufacturer on requisition No. 3,792. If the order is divided between two or more manufacturers, the lot numbers are to be run consecutively for each requisition. Thus, if on requisition 3,792, 300 tubes, or 3,000 feet, of safe-end material were ordered from one manufacturer, and 200 tubes, or 2,000 feet, of safe-end material from another, the lot numbers would be consecutive as given above, and only the manufacturer's name would be different.

No lot of tubes shall be used until the results of test are known.

One tube from each lot will be selected at random, and a piece 24 inches long must be cut from it and stamped with the manufacturer's name, together with the designating requisition and lot numbers of the lot to which it belongs. The remaining portion of the tubes from which the test pieces were taken must be preserved until test report is received.

Sample tubes will be properly tagged, tag giving the same information as stamped on the samples, which will then be shipped to Engineer of Tests, Altoona, Pa., where they will be subjected to the following tests:

7. A section of the tube 12 inches long must expand, cold, to 1 1/6 times its original diameter without splitting or cracking; the expansion to be obtained by forcing the small end of a tool steel pin, tapered 1½ inches to the foot, into the tube by means of light blows with a 10-pound hammer, or by a suitable press or expanding machine. In making this test care must be taken to have the end of the tube smoothly trimmed.

8. A section of the tube 2½ inches long, placed vertically, shall crush cold, flat on itself without splitting or cracking in any direction. This crushing test may be made by placing the tube vertically on the anvil of a steam hammer and subjecting it to a series of light blows, or it may be made in a suitable quick-acting hydraulic press. Light surface cracks on the outside of the bend will not be considered as condemning cracks, and one or two surface cracks shall not be considered as a failure, but if the cracks are more numerous, or if they penetrate, the tube will be considered to have failed on this test.

9. A test piece of tube 6 inches long, when flattened cold sideways, flat on itself, must not show any splits or cracks.

10. Etching and nicking tests will be made in case of doubt as to the quality of the material in the tube after the various tests have been made. The etching test must show a perfectly homogeneous surface, and the nicking test must not disclose laminations or any seam or cavity longer than ¼ inch.

11. In order that any shipment from one manufacturer shall be accepted, it is required that 75 percent of the samples from such shipment shall pass the above described tests without question. If the other 25 percent show results close to the requirements, shipment may be accepted at the option of the company. All tubes and safe ends are subject to the conditions of paragraph 12.

12. In addition to the above tests, individual tubes, which, when being inserted in the boiler, split or break, while being expanded or beaded, and also individual tubes which fail to pass the surface inspection, will be rejected.

MINIMUM WEIGHTS OF TUBES AND SAFE-END MATERIAL IN POUNDS PER FOOT.

0.2836 *Pound Per Cubic Inch and 3 Percent Off.*

Outside Diameter.	Thickness—Inches.					
Inches.	.095	.110	.120	.125	.134	.150
1.75	1.63 lbs.	1.87 lbs.	2.03 lbs.	2.11 lbs.	2.25 lbs.	2.49 lbs
2.00	1.87 "	2.15 "	2.34 "	2.43 "	2.59 "	2.87 "
2.25	2.12 "	2.44 "	2.65 "	2.75 "	2.94 "	3.26 "
2.50	2.37 "	2.73 "	2.96 "	3.08 "	3.29 "	3.65 "
3.00	2.86 "	3.29 "	3.58 "	3.72 "	3.98 "	4.43 "
3.50	3.35 "	3.86 "	4.21 "	4.37 "	4.68 "	5.21 "
4.00	3.85 "	4.44 "	4.83 "	5.02 "	5.37 "	5.98 "

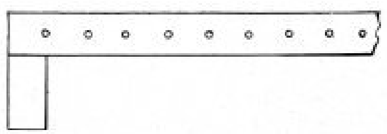
13. Rejected tubes and safe-end material will be returned to the manufacturer, who must pay freight charges both ways. The test samples representing the rejected tubes or safe ends will be preserved at the test room one month from date of test report. Accordingly, in case of dissatisfaction with the results of test, manufacturers must make claim for a rehearing, should they desire to do so within that time. Failure to raise a question for one month will be construed as evidence of satisfaction with the tests, the samples will be scrapped, and no claim for rehearing will be considered.

COMMUNICATIONS.

Cutting Off Hot Iron.

EDITOR THE BOILER MAKER:

Where there are a good many short pieces of hot iron to be cut off without a machine, and they have different lengths, so that it is not convenient to set a stop to mark off any special length, the square sketched herewith will come in handy for marking the bars with a punch. The sketch requires very little explanation. There are holes in the blade, just large enough to take in the end of a punch. If the holes are, say,



SQUARE FOR MARKING HOT IRON.

4 inches apart, and it is required to cut off two pieces each 4 inches long and one 8 inches long, the lengths may be pricked through the holes on the hot bar and the marks will be more permanent and more accurately spaced than if done with chalk. Where cold pieces are cut off to length with a saw, this contrivance marks them with accuracy and despatch. Where there are constructions requiring a certain number of pieces of the same diameter, but odd or different lengths, a special square may be made for each and the cutting points accurately indicated by holes bored through the square blade. R. G.

Rule for the Diagonal of a Square.

EDITOR THE BOILER MAKER:

In your January issue appears a communication from Mr. Frank T. Saxe, under the heading "A Useful Table for a Layerout," in which he gives a short-cut rule for finding the diagonal of a square, viz.: adding the legs together and multiplying the sum by the decimal .70781, which equals the length of the diagonal.

In the first place, the article should state that this rule can only be applied when the legs are of equal or the same length. Again, the constant .70781 is not correct and will not give the result accurately. For example, assuming the length of the legs to be 18 inches. Then, according to Mr. Saxe's rule the diagonal would be 25.4811 inches. By using the square root method we find the length is 25.4558 inches.

I am pleased to offer you a more reliable and simpler rule, viz.: multiply the constant 1.4142 by the length of one leg, and the result (by using the 18-inch leg) would be 25.4556 inches, or within 2/10,000 inch of being exact. It must be borne in mind, however, that this constant can only be applied when the legs are of equal length. G. A. SCHUST, M. E.

Fort Wayne, Ind.

TECHNICAL PUBLICATION.

Accounting Every Business Man Should Know. By E. E. Garrison. Size, 5 by 7¼. Pages, 188. New York, 1909: Doubleday, Page & Company. Price, $1.20 net.

The aim of this work has been to lay bare to business men the whole structure of modern accounting from foundation to summit. Simply and briefly the author explains the principles of business operation and finance and clears away all obscurities. The author is well qualified through an extended and varied business experience to deal with the subject in the most thorough manner. It is undoubtedly true that this subject has been little understood by many men whose business relations demand an intimate knowledge of the subject, and this merely from the fact that the real values and purposes of accounting are hidden in a multitude of details and obscurities. Great length and much detail are avoided in this volume, but the treatment is complete and very clear. It is a book which every business man should find of value.

PERSONAL.

FRANK T. SAXE, formerly foreman of the Wholey Boiler Works, Providence, R. I., is now traveling salesman for the William Allen Sons Company, boiler manufacturers, Worcester, Mass.

N. J. FITZHENRY, of South Bethlehem, Pa., is the chief inspector and constructor of the Bethlehem Steel Company, and not the company's foreman boiler maker, as was erroneously stated in our February issue.

JAMES J. FLETCHER, a former vice-president of the Master Steam Boiler Makers' Association, severed his connection as superintendent of the Manitowoc Boiler Works Company, Manitowoc, Wis., on March 1, and will assume the duties of superintendent of the Casey-Hedges Boiler Company, Chattanooga, Tenn., about the 1st of April.

With the February number of *The Electrical Record*, Albert Spies retired from the editorship of that publication, to become the managing director of *Foundry News*, a new illustrated monthly publication devoted to the foundry arts, with offices in the Hudson Terminal, 50 Church street, New York. *Foundry News* will make its first appearance in April.

ENGINEERING SPECIALTIES.

Performance of Locomotives Equipped with the William H. Wood Patent Locomotive Firebox and Tube Plate.

Three locomotives, belonging to the New York Central & Hudson River Railroad Company, have for some months been equipped with the William H. Wood patent corrugated firebox and tube plate, and these locomotives have been running in competition with others of the same size and details of the ordinary construction. The conditions of service have been the same, and a careful record of the performance of the two types of locomotives has been kept in order to arrive at a fair conclusion regarding the value of the Wood construction. Reports from Mr. H. Snell, the locomotive expert, employed by the William H. Wood Company, indicate that the boilers fitted with the Wood fire-box are doing superior work to those of the regular type, inasmuch as they are better steamers and use less coal.

The locomotives are not being tested with any great degree of scientific refinement, but the amount of coal lying in the tenders on the return trips for approximately the same tonnage and number of cars hauled by each class of engines is measured, and, in this way, the locomotive fuel consumption of the two types is roughly estimated. The firemen on these engines have been changed from time to time, in order to note the different results, but this apparently has made little or no difference in the quantity of fuel used. The saving in coal by the engines equipped with the Wood fire-box and tube plate is claimed to be over 15 or 20 percent of that used by the ordinary type locomotive.

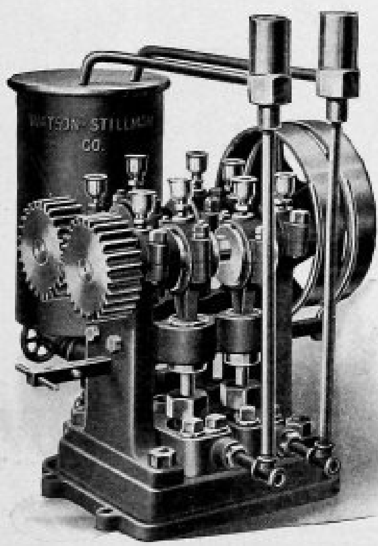
As to the mechanical difficulties with this construction, it is reported that engineers who have operated these engines claim that they have never seen any tubes leaking while the engines are on the road, and it is the opinion of the locomotive expert that the tubes could be run from four to five months without putting an expander in them, and if it was not for the fact that the fires are dumped so often, and the engines run into the roundhouses on their own steam, taking cold air through the fire-box and tubes, they would go on working indefinitely without having any trouble from leakage.

There has not been a broken staybolt in these locomotives since they were put in service. After one of the engines had been running nearly nine months, without missing a trip, the interior was examined carefully, and it was found that the fire-box and tube plates were in first-class condition, and that they did not scale any more than the regular plain fire-boxes and tube plates. It is reported by the locomotive expert that there have been no leaky or broken staybolts and no leaky mudrings on any of the boilers equipped with these fire-boxes and tube plates since he has been watching them. There have been several leaky crown bolts from time to time, caused by dumping the fires, but this was of no consequence and was easily repaired.

This report seems to endorse the statement made by Mr. Wood that every extra square inch of surface put into the fire-boxes and tube plates by flanging will give an account of itself in shape of fuel economy.

A Small but Powerful Hydraulic Pump.

The four-cylinder, two-pressure line hydraulic pump illustrated represents a new Watson-Stillman type, by means of which one, two, three or four pressure lines may be served

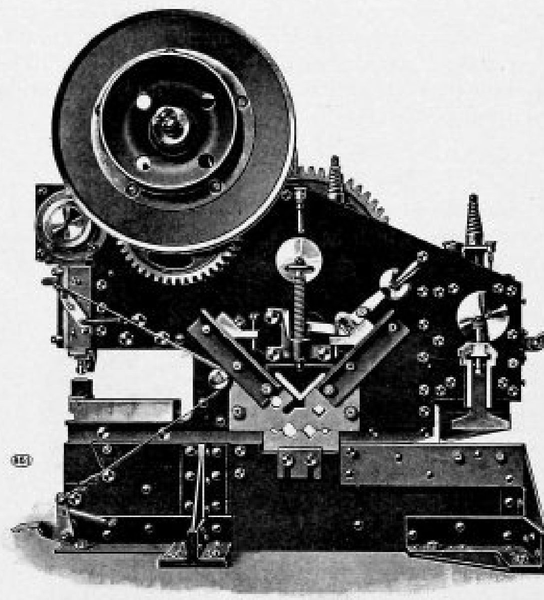


independently of each other, but from a common reservoir. Each pressure line has a separate pressure chamber, safety valve and release line, and is served by a separate pair of cylinders (½ inch diameter by ½-inch stroke) having eccentrics set to give a continuous flow. It is claimed that any pressure up to 600 pounds per square inch may be delivered into any line, the limit in each instance being determined by the setting of the safety valve, which opens as the pressure tends to exceed the limit and lets the surplus liquid pass back through the release pipe to the reservoir. Any pressure line can be thrown out of service entirely by opening the safety valve, in which instance all the liquid in that line pumps directly back to the reservoir.

The one, two, three and four-pressure line pumps are practically the same in design save for change in the length of the bedplate and the shafts to accommodate the required number of pressure chambers, cylinders, piston rods, eccentrics, etc., and may be fitted with an electric motor instead of the pulley shaft shown. These pumps are made by the Watson-Stillman Company, of New York.

A Triple-Combined Plate Shear, Punch and Bar Cutter.

The illustration shows a triple combined punch, shear and bar cutter manufactured by Henry Pels & Company, 90 West street, New York. This machine combines a fairly complete shop equipment in one frame, and the design is such that all the tools can be used simultaneously at their maximum capacity. The frame of the machine is built of heavy steel plate from 2 to 4¾ inches in thickness, depending upon the



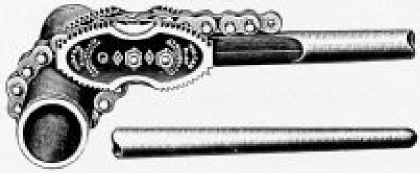
size of the machine. This style of frame, which is used in all this company's machine tools, is claimed to be unbreakable.

The punch, shear and bar cutter are provided with separate stop motion. The punch is equipped with an architectural jaw for punching boiler heads as well as the webs and flanges of structural shapes. The punching end can be built for any depth of throat and with a capacity for punching from ¾-inch holes through ⅜-inch material up to 1½-inch holes through 1¼-inch material. The bar cutter is arranged so that the angle and tee blades can be interchanged with blades for cutting beams, channels, zee bars, or any desired rolled section. Angles are cut square as well as on a bevel. The splitting shear is built for cutting plates of unlimited lengths and widths up to any capacity desired. The straight and tangent channels of the splitting shear are milled out of the main frame and have no fillets, so that easy feeding of the plates through the machine is insured.

This tool is built in seven sizes, for handling from ⅜-inch material up to 1¼-inch on the splitting shear, and for cutting from 1-inch up to 3-inch round bars on the bar cutter, as well as from 3-inch to 8-inch angles with other shapes in proportion. The tool is claimed to be a great time and labor saver, and occupies only a minimum amount of floor space.

Vulcan Bijaw Chain Pipe Wrenches.

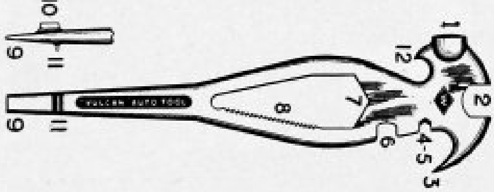
J. H. Williams & Co., Brooklyn, N. Y., who, since 1884 have been developing chain-pipe wrenches, have just brought out a new wrench known as the "Vulcan Bijaw." This wrench is made with double-ended reversible jaws, which can be readily turned end for end when the tool wears, thus doubling the life of the tool and insuring that it will be always ready for service. Two studs or bolts through the



handle prevent the spread of the jaws when in use. The material in these studs is of great strength, and in case of accident repairs may be made on the spot by moving forward the rear stud, since it is claimed that one bolt or stud will still provide working strength for the tool. The application of the jaws to the handle remains the same milled construction which has given satisfaction for so many years in the "Vulcan" wrenches manufactured by this company. These wrenches are made in sizes for ⅛ to 12-inch pipe and fittings, with interchangeable cable or flat-link chains.

The Vulcan Auto Tool.

The illustration shows a handy tool for the motorist or motorboat owner, which has just been placed on the market by J. H. Williams Company, Brooklyn, N. Y. The tool has



no moving parts, yet it can be used for the following purposes: hammer, a tire lug wrench, cotton pin puller, gas-tank wrench, wire insulation scraper, air-tank wrench, spark-plug wrench, alligator wrench, cotter pin spreader, three screw drivers and a bottle opener.

Correction.

On page 43 of our February issue, in the table of railroads and other companies operating five or more locomotives in New York State, as reported to the Public Service Commission, Dec. 1, 1909, the total number of boilers reported to the Commission by the New York Central lines should be 2,702 instead of 2,072, as stated.

Another Fatal Boiler Explosion.

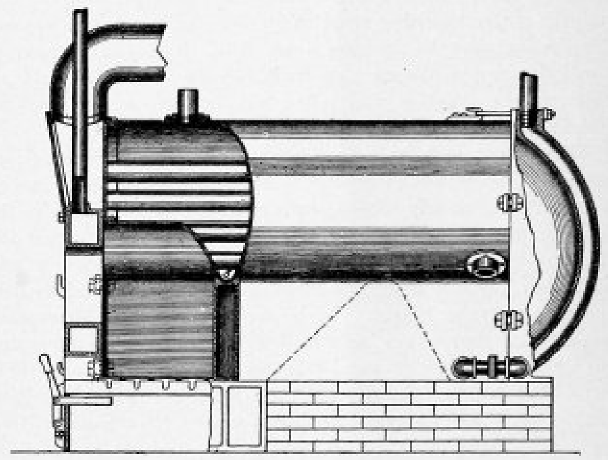
Five men were scalded, three fatally, in a boiler explosion at the electric lighting plant, Flint, Mich., on Feb. 5. The three men who were killed were repairing a boiler which exploded two days previously, when the boiler opposite the one on which they were working exploded. The escaping steam filled the boiler in which the men were at work. As a result of the explosion and loss of power, four thousand factory men are idle.

SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Loan and Trust Building,
Washington, D. C.

940,684. BOILER. DANIEL HANLON, OF SPOKANE, WASH.

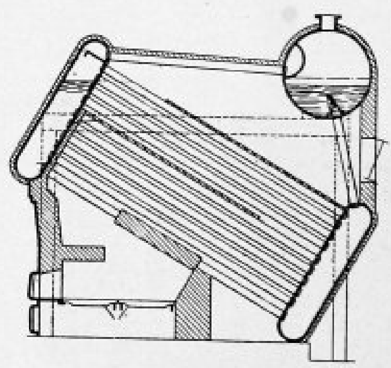
Claim.—A boiler comprising a suitable base, a water-containing shell disposed above the base and having an under side concave in cross-section and also having longitudinal hollow depending portions at opposite sides of said concave underside, longitudinal flues extending through said shell, a front hollow water-containing section superposed on the base and arranged in front of the shell, a rear hollow water-containing section, superposed on the base and having a concave inner side opposed



to the rear end of the shell, side hollow water-containing sections superposed on the base and interposed between and connected with the front and rear sections and having crosswise concavities in their upper sides receiving and holding the depending side portions of the shell, and an uptake arranged above the front water-containing section and adapted to receive products of combustion from the forward ends of the flues in the shell. One claim.

941,462. STEAM GENERATOR. JOHN C. PARKER, OF PHILADELPHIA, PA.

Claim 2.—A steam generator having a water circuit comprising a bank of inclined tubes with headers connecting their respective ends and a restricted auxiliary circuit connected therewith, in combination with



means for applying the primary action of the heating gases to the upper ends of the lower tubes, means for directing said heating gases from the upper ends downwardly along said lower tubes, and means for directing said heating gases from the lower ends of the lower tubes upwardly along the upper tubes. Fifteen claims.

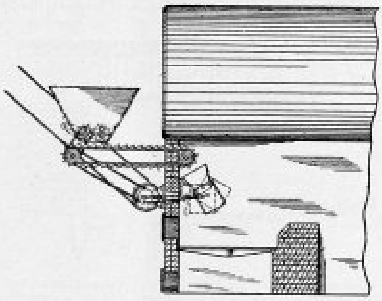
941,658. FURNACE. MINOTT W. SEWALL, OF ROSELLE, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 2.—A plurality of boilers spaced apart forming passageways therebetween, furnaces for said boilers, the grate surface of said furnaces extending over the floor space betwen contiguous boilers and the floors of said passageways constituting portions of the furnace roofs, and means for separating contiguous furnaces. Eight claims.

941,820. WATER-TUBE BOILER. JAMES P. SNEDDON, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 2.—A vertical water-tube boiler having firing openings at both ends, steam drums having a common water level, mud drums arranged adjacent the firing openings, banks of tubes forming circulating connections between the several drums, and baffles arranged to direct the products of combustion toward the central portion of the boiler. Seven claims.

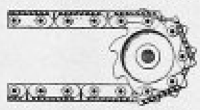
941,486. STOKER. GEORGE ANDERSEN, OF CHICAGO, ILL.
Claim.—In a device of the class described, a furnace having the usual walls and grate, in combination with a fuel hopper and a fuel chute,



means for feeding the fuel to said chute in measured quantities, an oscillatory nozzle of greater diameter than the end of said chute and pivotally mounted over the same for distributing the fuel over said grate, a rotary shaft arranged in front of said furnace and substantially parallel with the front wall thereof, a crank disk on said shaft, a pitman connecting said crank disk and said nozzle and sprocket gearing connecting said shaft with said fuel feeding means. One claim.

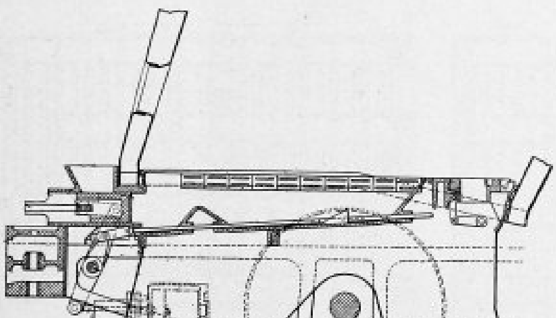
941,480. FURNACE. LEE WHITTAKER, OF BUTLER, PA.
Claim 1.—In a furnace, a fire-box having inwardly and downwardly inclined side walls, a perforated arch substantially covering said fire-box, a fuel and air mixing chamber arranged at one side of said arch and opening into said fire-box, means for feeding fuel through said mixing chamber into said fire-box and means for injecting cool air into said mixing chamber and mixing the same with the fuel in sufficient quantities to maintain the fuel in the mixing chamber below the ignition point. Two claims.

941,572. FURNACE GRATE. FREDERICK GIRTANNER, OF ST. LOUIS, MO., ASSIGNOR TO LACLEDE-CHRISTY CLAY PRODUCTS COMPANY, OF ST. LOUIS, MO., A CORPORATION OF MISSOURI.
Claim 1.—In a furnace grate, the combination with a plurality of rows of links, said links being arranged to allow the passage of a



greater volume of air at the center of the grate than at the sides, of means for driving said links to feed the fuel. Four claims.

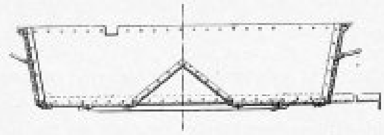
941,698. MECHANICAL STOKER FOR LOCOMOTIVES. DAVID FRANCIS CRAWFORD, OF PITTSBURG, PA.
Claim 1.—The combination of a locomotive furnace, an under-feed trough extending into the furnace, a feed cylinder located at the rear of the trough and provided in its sides with guide slots, guide members



extending rearwardly from the opposite sides of the cylinder and provided with slots forming continuations of the first guide slots, a feed piston in the cylinder, a cross-head secured to the piston fitting the guide slots, crank arms secured to the cross-head on opposite sides of the cylinder, and means for oscillatiing the crank arms. Three claims.

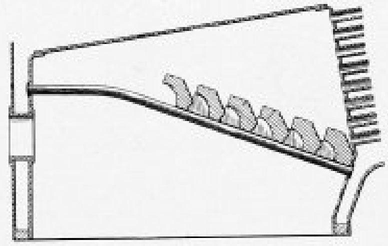
942,798. BOILER-TUBE CLEANER. JOHNSON V. SYMONS, OF JOHNSTOWN, PA., ASSIGNOR TO LIBERTY MANUFACTURING COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.
Claim 1.—A tube-cleaning tool, comprising a head, having an undercut flange at one end, and a plurality of longitudinal extending slots forward of said flange, a plurality of cutter blades removably seated in said slots, and clamping means at the opposite end of the head for securing the blades in said slots; substantially as described. Two claims.

943,777. ASH-PAN FOR LOCOMOTIVES. JOHN HENRY GEE, OF PALESTINE, TEX.
Claim.—An ash-pan including a body open at the bottom, L-shaped guide rails secured upon the sides of the body and extending beyond one end thereof, the lower portions of said rails being disposed above the bottom of the body and each rail having a depending stop projection upon the projecting end thereof, spaced slides bearing upwardly against the bottom of the body and against the guide rails, supporting members extending transversely under the slides and having hooked terminals projecting upwardly therefrom and engaging the guide rails, the projections upon said rails extending into the path of the slides to limit



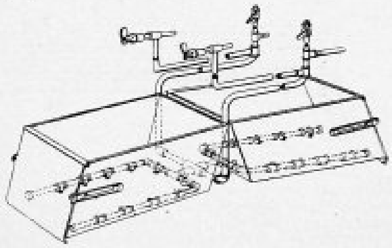
the movement thereof in one direction, ears extending laterally beyond the slides, connecting devices detachably engaging the ears, and a pitman for actuating the slides. One claim.

942,575. ARCH FOR FIRE-BOXES OF LOCOMOTIVES, ETC. JOHN LOFTUS, OF ALBANY, N. Y.
Claim 1.—In combination with a fire-box and boiler flues of a locomotive, an arch made up of rows of brick spaced apart and positioned within the fire-box and having their opposite faces inclined with respect



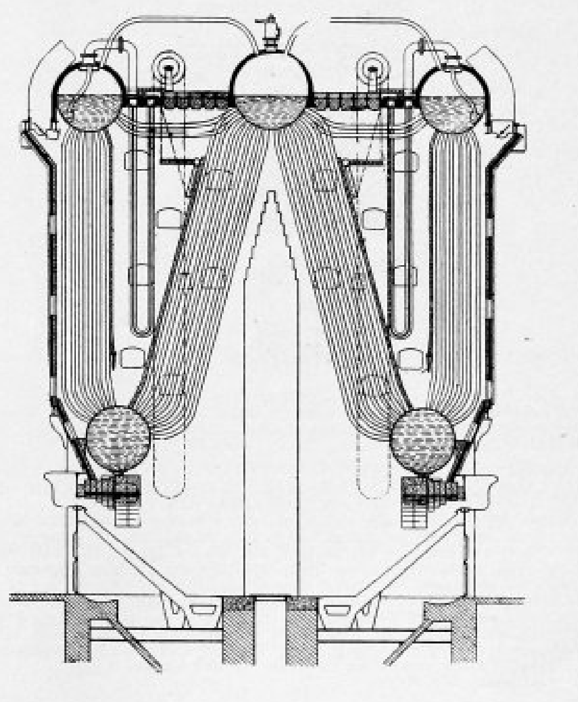
to the horizon and away from said flues, flanges projecting from the under faces of the brick and having their lower edges inclined and in alinement with one another and against which flanges the adjacent rows of brick are adapted to bear. Five claims.

942,737. DEVICE FOR CLEANING ASH-PANS OF LOCOMOTIVES. NELS OLSON, OF BIRMINGHAM, ALA.
Claim 2.—The combination with an ash-pan of the character described and an injector, of a pipe provided with nozzles adapted to discharge into said ash-pan, a feed-water pipe leading from the injector, a connec-



tion between said first-named pipe and the feed-water pipe, and a connection between the overflow port of the injector and said first-named pipe, said last-named connection being provided with a check valve opening toward the first-named pipe. Four claims.

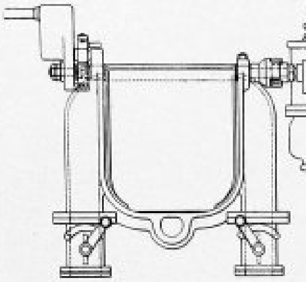
942,797. WATER-TUBE BOILER. JAMES P. SNEDDON, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.



Claim 2.—A water-tube boiler of the class described having a central primary combustion chamber and provided with firing openings at both front and rear of the boiler setting, a plurality of escape flues, and baffles for dividing the products of combustion from the central combustion chamber and directing the divided currents independently toward said escape flues. Eleven claims.

942,822. FURNACE DOOR. GUSTAV DE GRAHL, OF WILMERSDORF, NEAR BERLIN, GERMANY.

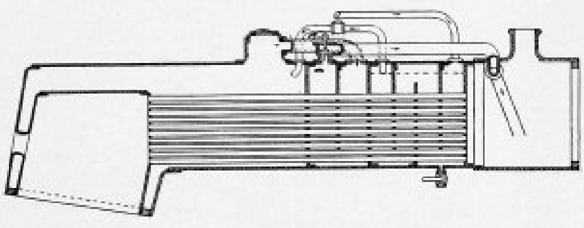
Claim 1.—In a device of the class described the combination of a furnace provided with a door opening, a shaft on the furnace, a door on the shaft for closing the door opening and able to swing inward, of



a counter-weight revoluble on said shaft and adapted to balance said door, and a sector having two shoulders fixed on said shaft, said counterweight being adapted to coact with and actuate said sector. Three claims.

943,189. STEAM GENERATOR, SUPERHEATER, AND FEED WATER HEATER. FRANK A. HAUGHTON, OF NEW YORK, N. Y.

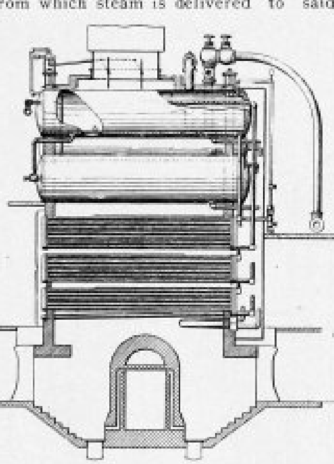
Claim 2.—In a fire-tube boiler, a steam generator, a feed-water preheater, and a steam superheater, each of these parts separable from the other and having means whereby each may be attached to the adjacent



part, tube heads and fire tubes for each of the parts, the tubes being so positioned in each part as to register with the tubes of the next part to form continuous passages through the several parts when the same are assembled, connections from the feed-water preheater to the steam generator, and from the latter to the steam superheater. Seven claims.

943,452. STEAM BOILER. JOHN C. PARKER, OF PHILADELPHIA, PA.

Claim 7.—In a steam boiler, in a single setting, feed wated tubes, a storage drum to which water is delivered by said tubes, a generator having a drum from which steam is delivered to said storage drum, a



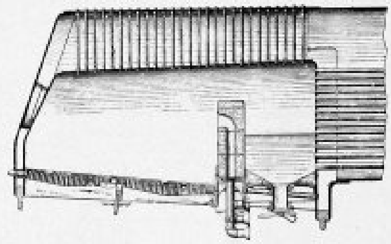
conduit by which water is delivered from said storage drum to said generator drum, superheater tubes to which steam is delivered from said generator drum, and a superheat storage drum to which steam is delivered from said superheater tubes. Fourteen claims.

943,942. LOCOMOTIVE AND OTHER FURNACE. ALBERT F. KINGSLEY, OF NEW YORK, N. Y., ASSIGNOR TO LOCOMOTIVE EQUIPMENT COMPANY, A CORPORATION OF MAINE.

Claim 3.—In a furnace, a fire-box, a fire arch projecting into the fire-box from one wall of the fire-box and having an air passage therethrough from that edge of the arch which rests against the wall to suitable points in the surface of the arch within the fire-box, the wall from which the arch projects having therein opposite the edge of the arch an air inlet, a tubular connection from the air passage in the fire-box wall to the air passage in the arch, and the edge of the arch being cut away at the mouth of the air passage to permit of a bend in said tubular connection when the opening in the fire-box wall does not register with the mouth of the passage in the arch. Seven claims.
for said link. Six claims.

943,823. LOCOMOTIVE-BOILER FURNACE. FREDERICK F. GAINES, OF SAVANNAH, GA.

Claim 1.—The combination, with a locomotive boiler fire-box, of a bearer extending across the fire-box near the bottom thereof and attached at its ends thereto, a bridge wall of refractory material supported on said bearer and dividing the interior of the fire-box into a rear fire



chamber space and a forward combustion chamber space, a bar grate extending longitudinally at the bottom of the fire chamber space, and a plurality of water grate tubes, alternated in position with the bars of the grate and extending from the rear to the front water wall of the fire-box and below the combustion chamber space. Four claims.

945,574. GRATE-BAR. HART H. McNAUGHTON AND PETER McNAUGHTON, OF CHARLOTTE, MICH.

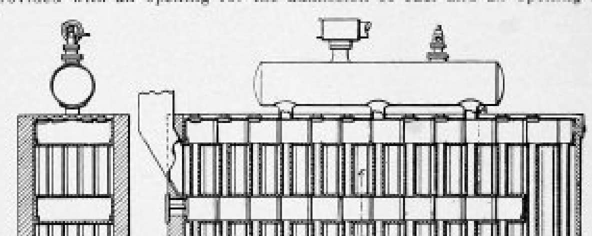
Claim.—A grate bar comprising end members, parallel bar members rectangular in cross section and of uniform transverse width and thickness, throughout their length detachably connected at their ends to the end members, and wing members mounted upon the bar members and having web portions provided with openings and located between the bar members and extending below the parallel bar members and provided on opposite sides with laterally disposed recessed shoulders which space the sides of the webs from the sides of the bar members and which extend below the parallel bars and lock the wing members on the same, the same web portions having wedge shaped end portions, the edge portions of which project over the upper edges of the bar members and are spaced from the same. One claim.

945,590. FLUE-SRIP FOR BOILER AND OTHER FURNACES. ALFRED E. PFAHLER, OF PHILADELPHIA, PA., ASSIGNOR TO MODEL HEATING COMPANY, OF PHILADELPHIA, A CORPORATION OF PENNSYLVANIA.

Claim 1.—The combination of a furnace having sections shaped to constitute a flue a portion of whose wall is formed by two members spaced apart; with a flue strip having a head and a web; the head resting on said spaced members, and the web extending between the members. Four claims.

945,733. STEAM BOILER. CHARLES ANDREW STURM, OF PORTLAND, OREGON.

Claim.—A steam boiler comprising a bottom chamber partially surrounding the fire-box, an upper chamber connected with the steam dome, a lower intermediate chamber extending from the front to a distance from the back, an upper intermediate chamber extending from the back to a distance from the front, a wall inclosing said chambers and provided with an opening for the admission of fuel and an opening for



the smoke and gases to flow out from between the upper, and upper intermediate chambers at the rear thereof, and pipes connecting the front portion of the lower chamber with the lower intermediate chamber, the rear end of the lower chamber with the upper intermediate chamber, the rear end of the lower intermediate chamber with the upper intermediate chamber, the front end of the lower intermediate chamber with the upper chamber, the upper intermediate chamber with the upper chamber. One claim.

945,756. WATER GAGE FOR BOILERS. THOMAS R. COOK, OF FORT WAYNE, IND.

Claim 2.—The combination with a water glass gage, of a valve mechanism at each end thereof, each comprising a body communicating with the gage and boiler, a sleeve mounted for longitudinal movement in the body, a valve stem carrying a disk threaded through the sleeve, and a bonnet threaded to the body and adapted to clamp the sleeve in position and provided with a stuffing box for stem and the valve. Two claims.

945,595. STEAM BOILERS FURNACE. CHARLES HENRY KNOWLES, OF NEW YORK, N. Y.

Claim.—The combination in a furnace, of a combustion chamber, a grate in the forward portion thereof, a bridge wall disposed at the rear end of the grate, longitudinal conduits supported by and extending in rear of the bridge wall and located at opposite sides of the grate, a crosswise conduit joining the rear ends of the longitudinal conduits and having discharge apertures, and conduits communicating at their forward ends with the atmosphere and extending rearwardly through the front wall of the combustion chamber and upwardly to points above the grate and communicating with the forward ends of the longitudinal conduits; the said longitudinal conduits being detachably connected with the other conduits, and spiral, air-retarding blades arranged in the said longitudinal conduits. One claim.

THE BOILER MAKER

APRIL, 1910

SOME RECENT BOILER REPAIRS BY THE OXY-ACETYLENE PROCESS.

BY EVAPORATE.

There are many boiler makers who still hold to the opinion that the only safe way to join together plates which are under tension is by riveting. They refuse to be convinced that plates which have been welded by the oxy-acetylene process have really been welded at all, in the sense that the plates to be united have not been hammered. They admit, however, that the metal is more or less fused together, but the strong evidence of successful application of this process to large jobs of repair work is needed to fully establish it as a reliable method of accomplishing boiler repairs. The following instances furnish evidence of this kind, and it is only fair to say at the outset that in these cases the process has proved thoroughly beneficial and reliable.

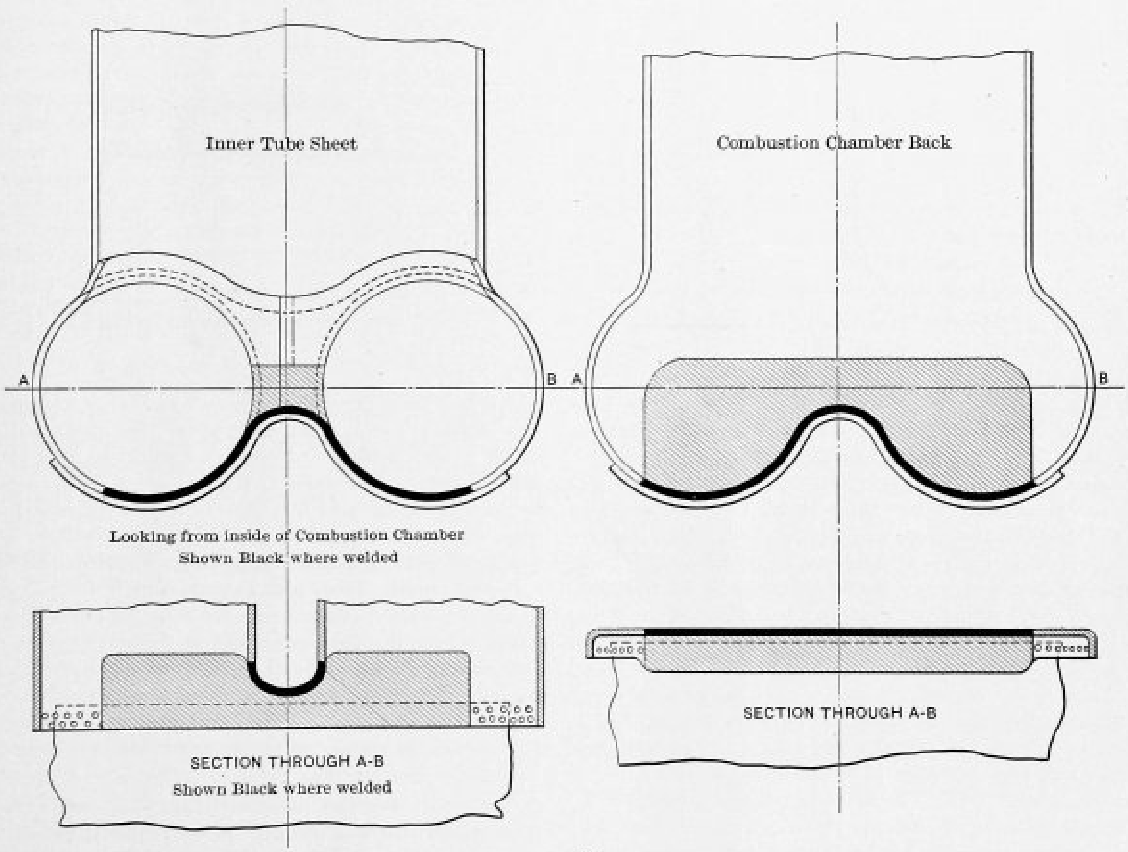


FIG. 1.

RENEWING A HALF TUBE SHEET AND CROWN SHEET.

The first repair job which the writer will describe is that carried out on the boiler of a steam fishing vessel which had been at sea only a few hours when, owing to a misunderstanding of the instructions given him, the second engineer allowed the water to become too low in the boiler, which fact, coupled with a defect in the water column, where the water apparently stood at three-quarters of a glass, had the effect of burning the boiler and causing one of the combustion chamber crowns to collapse. Not only did the top of the port combustion chamber bulge into the chamber several inches, but the tube holes in the top row were badly ovaled. The flange of the tube sheet gave in several inches, and the flange of the plate forming the back of the combustion chamber was also badly bent where it was riveted to the crown plate. Taken altogether the damage was serious.

As is usual in such instances, it was considered necessary to remove the boiler from the vessel, take the whole inside adrift and proceed to fit a complete new tube sheet, etc. Before this was done, however, the possibility of welding a new half sheet was considered, and this method was finally adopted, the job being eventually accomplished without disturbing more than a few tubes to admit of access to the tube sheet on the inside of the boiler.

The girder stays were removed from the top of the combustion chamber, which was entirely renewed and the crown plate was cut away. Tubes were removed where necessary, and the top half of the tube sheet only was cut out, as shown in Fig. 2, at a line through the fourth row of tubes. A new half-sheet was flanged so as to make a good fit at the corners, and all holes for the tubes and rivets were drilled. The half-sheet was then securely bolted up in position while the edges of the plates between the holes at the fourth row of tubes were V'd out to facilitate the welding. The line of welding which, as will be noticed, was through the centers of the tube holes, was selected in order to give the least possible amount of welding.

An attempt was next made to unite the plates in the usual manner. A thin strip of plate, 1 inch by ¼ inch, was fixed over the line of the proposed weld on the inside of the boiler, which enabled a ready start to be made in the filling up the V on the furnace side. The French blow-pipe was used on this job, as this torch has proved very reliable on difficult jobs.

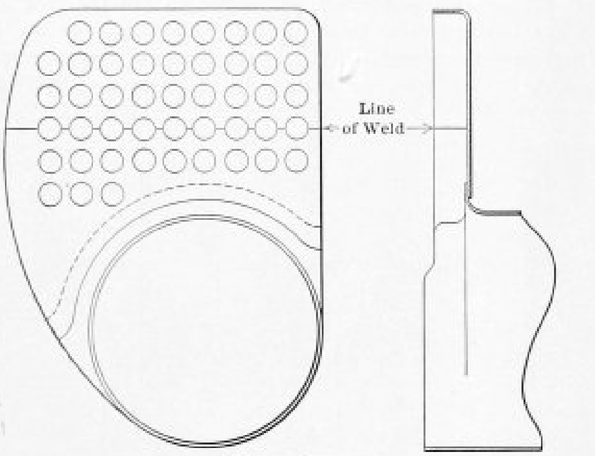


FIG. 2.

Swedish iron, in the form of rods about 3/16 and ¼ inch diameter, was used for filling up the V. A flame from a blow-pipe was kept constantly blowing on the inside of the boiler against the inside of the plate at the point where the welding was going on. When the welding had been accomplished the rivets in the flanges of the tube sheet were driven and the girder stays replaced. The line of tube holes through which the weld passed was formed by one-half of the hole remaining in the original tube sheet, the other half having previously been drilled somewhat smaller in the new half of the sheet, so that when the welding was completed the holes could be reamed out to the required size of the new tubes by means of an ordinary tube-hole reamer operated upon the smoke-box end of the boiler. The stay-tube holes were tapped in the same way and the tubes soon placed in position.

The riveting and calking were accomplished without mishap, although the riveting in some respects was a difficult job, as it was practically single handed all the time, since it was impractical to turn the boiler around.

The boiler was eventually tested to one and one-half times the working pressure and the weld was found to be perfectly tight.

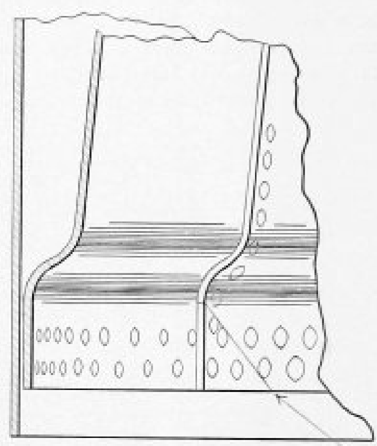
RENEWING WASTED LANDING EDGES.

The joints on the inside of a vertical or donkey boiler are a frequent source of trouble where leaks at the bottom of the cone where the cone is riveted to the shell have been allowed to waste the landing edges. The work of putting these troublesome corners to rights has always been difficult until the introduction or application of the oxy-acetylene process of welding. By this means, however, the work becomes comparatively simple and easy.

In the case shown in Fig. 3 the wasted corners at the bottom of the cone of the vertical boiler were cut away as shown and a new plate of similar dimensions to the piece cut away was securely bolted up in place and welded. After the welding had been accomplished the riveting and then the calking followed in the usual way. The line of welding in this instance is shown on the sketch.

RENEWING THE BOTTOM OF A COMBUSTION CHAMBER.

One of the largest boiler repair jobs which has been successfully accomplished by oxy-acetylene welding is shown in Fig. 1. In this case the repairs were to the bottom of the center combustion chamber of the boiler of a cargo steamer. The boiler had four separate furnaces, the two center ones merging into a single combustion chamber. Due to frequent leakage caused by an excessive amount of "breathing" or expansion and contraction at the seams at the bottom of the center chamber, just where the furnaces proper enter the chamber, the plates were very badly wasted and the landing



New corner piece of plate welded at this line

FIG. 3.

edges had been chipped again and again for calking until it was beyond doubt unwise to allow the boiler to be under steam longer without making some effort to stop the trouble permanently. The sketch, Fig. 1, gives some idea of the amount of metal which it was necessary to renew, but perhaps the magnitude of this particular job will be better appreciated when it is known that some 30 feet of cutting out was performed. Blow pipe cutters were not used on this job at all, the wasted pieces being cut away by hand. Part of the seam, where the furnaces unite at the center, was cut away and practically the whole of the bottom of the chamber was removed. The bottom plate, forming the back of the chamber, also had to be dealt with, and that part of it immediately opposite each furnace, containing some eighteen stays, was cut clear.

The entire edge of the remaining plate where cutting had been performed was chipped to the required bevel; that is, it was V'd out so that the welding could be performed. All of the edges of the new patches were similarly treated. Where it was necessary to flange any of the patches this was done on a hydraulic press. The new pieces were placed in the chambers in six different patches, two of which replaced parts of the furnace which had been cut out, two being required for renewals in the bottom of the combustion chamber proper, while two pieces were required to make good the back of the fire-box with nine stays in each, screwed through them and through the back end of the boiler.

To those who are aware of the patience, endurance, initiative and the skill which the process of oxy-acetylene welding demands in a situation where the quarters are as cramped as in a combustion chamber, this particular job must appeal, and apart from other considerations, such repair work as this must enable the insurance and other surveyors to form better opinions of the new and drastic method of dealing with troublesome boilers.

At every point throughout the job where it was possible, a strip of plate was fused on the line of welding, and at all points a blow lamp was applied on the inside of the boiler around the precise spot where welding was being performed. This was done in order to preserve a fair heat through the plate being welded.

After the welding had been finished, the stays, etc., were soon replaced, and, as this vessel has been making regular trips for the past three months since the repairs were completed, a sufficiently exacting test has been carried out to demonstrate that in this case at least the oxy-acetylene method of repairing was in every way satisfactory.

CLOSING UP CRACKS IN FURNACES.

Without attempting to go into all of the possible applications of this method in repairing boilers, attention should be called to a certain class of repairs for which this process is being very largely applied, namely, closing up cracks in furnaces. Such defects were formerly remedied by pinning up the crack; that is, stopping it by means of a pin set into the plate. As compared to this method, however, the advantage of the present method at once appears. Three such examples have recently come to the writer's attention, and in these cases repairs have been most satisfactorily performed. Two of them were in a corrugated furnace, while the third was in a plain furnace. The cracks appeared along the line of the fire-bars or slightly above that line. Where such a crack has assumed a straight line it is sufficient merely to bevel the sides of the crack the same on both sides, and to proceed with the welding, but where a crack has been previously pinned up and, by reason of the increased opening, it is imperative that the old pins be cut out, a piece of plate of similar dimensions to the part cut out is fitted and welded circumferentially. In one instance of this kind the piece cut out measured 9 by 3 inches and when the new piece was welded in and a hydraulic test of one and one-half times the steam pressure was on the boiler a man was instructed to deal several blows on the parts welded with a hammer weighing four pounds, but this failed to show even the least indication of a leak, to say nothing of a fracture.

SOMETHING ABOUT BOILER STRESS FORMULAS.

BY CHAS. J. MASON.

The pressure of steam exerted in a boiler causes certain stresses to occur, which stresses may be calculated by the employment of certain factors in formulas. We frequently see various formulas applied to steam boilers in all the engineering magazines of the day, but I wonder how many readers who are not technical graduates understand just what formulas these are and how each one is applied. It has occurred to me to group what may be considered the most important ones, and explain them, for I believe that by bringing them together the use of each will the better be understood by those who at present are not quite sure about the matter.

Let us consider the ordinary horizontal tubular boiler. The tendency of the pressure is to blow off the heads in a horizontal direction and, as well as that, to separate the shell along the sides in a direction at right angles to the horizontal. If the heads are so braced as to resist bulging outward the resistance offered to the pressure is simply the thickness of plate in the circumference. The thickness of the circumferential ring referred to is called the cross sectional area of metal resisting the heads being blown off. One head only need be considered, for each acts as a backing wall for the other, so to speak, and as action and reaction are equal and opposite, it can easily be understood how one head only need be considered in this connection. Now the formula to be used to find the stress per square inch of section in the ring of metal, caused by the pressure of steam tending to blow off the head, is this:

$$\frac{a \times p}{d \times 3.1416 \times t} = S.$$

In which a = area of head upon which the steam pressure acts; expressed in square inches.
p = pressure per square inch in the boiler.
d = diameter of shell in inches.
t = thickness, in inches, shell plates.
3.1416 = a constant employed to find the circumference.
S = the stress per square inch section endured by the metal expressed in pounds.

If the boiler were rectangular in form instead of cylindrical, as we have just been considering it, then the thickness of the metal in the four sides may be said to resist the head or end being blown off. The four sides in this case are the same as the circumference of the shell in the first case alluded to. If we assume that the boiler is square in cross section, then the distance across from one side to the other corresponds to the diameter if the boiler were circular in cross section. Remembering this, the following formula may be used as well as that given before:

$$\frac{p \times d}{4t} = S.$$

In which p = the pressure per square inch as before.
d = the diameter in inches or the distance corresponding to the diameter.
t = thickness in inches of plates.
S = stress per square inch section endured by the metal expressed in pounds.

The factor 4 corresponds to the four sides, and it may be used as well when considering the boiler as circular in cross section.

Both rules give the same result because they are based upon the same principle, although the *application* is not exactly the same.

The tendency for the shell of the boiler to separate in two parts along the sides at points diametrically opposite, is resisted by the thickness of the metal at both sides. Imagine the pressure to act on a plane whose area is the diameter of the shell times the length of the shell. Of course the force due to the pressure within the boiler radiates from the center, but this force may be resolved into two sets of forces, so to speak, which act from the plane at right angles to it. The formula to be employed for this stress is:

$$\frac{d \times l \times p}{2l \times t} = S.$$

in which the letters have the same value as before, and l equals the length in inches. As l appears in both the numerator and denominator, it may be cancelled and the formula may be simplified like this:

$$\frac{d \times p}{2 \times t} = S.$$

With the exception of the numeral 2, it will be noticed that this formula is the same as one of those given for the head stress, in which the number 4 appears instead.

A study of these formulas will make clear and explain why the stress along the sides of a boiler is just twice that in the other direction, as indicated by the numbers 2 and 4 in their respective formulas. This is difficult to understand by some who have not had their attention called to the matter in the way of analyzing the formulas just presented.

The stress on *each inch* in the circumference, independent of what the *thickness* of the plate may be, and in a longitudinal direction, is found from this formula:

$$\frac{a \times p}{d \times 3.1416} = s.$$

This formula should not be confounded with the other which resembles it, excepting for the presence of the factor t. The other relates to stress *per square inch section,* which must take the thickness of the plate into account. The value of s in this latter does not relate to *per square inch section,* but to *each one-inch division* around the entire circumference.

The *total stress* caused by the pressure within the boiler on the entire shell is found from this formula:

$$d \times l \times p = \text{total stress in pounds.}$$

But the *total pressure* on *all the square inches* in the entire shell is:

$$\text{Circumference} \times l \times p = \text{total pressure.}$$

The formula for the *bursting pressure* per square inch is this:

$$\frac{t \times s \times T}{r} = \text{bursting pressure in pounds per square inch.}$$

In which t = thickness in inches of plate in the shell.
s = percentage of strength of the longitudinal seam.
T = tensile strength of the plate in pounds per square inch in section.
r = the radius of the boiler in inches.

The formula for the safe working pressure is stated like this:

$$\frac{t \times s \times T}{r \times f} = \text{safe pressure per square inch.}$$

Here the letters are the same as for the bursting formula, with the addition of the factor f, which represents the factor of safety which is to be employed. In some cases the factor of safety is 5, and in some others 6 is used, particularly in stationary boilers. When the percentage of strength of the joint is not known exactly, it is customary to use .70 for double-riveted joints and .56 for single-riveted joints. The strength of a joint may vary from 56 percent to as high as 94 percent, according as to how the joint is made and how the rivets are spaced and sized.

BOILER ATTACHMENTS AND FUNNEL DRAFT.

BY LIEUT. H. K. SPENCER, U. S. R. C. S.

Assuming that the proper grate area and heating surface have been assigned to boilers designed to furnish a required amount of steam at a certain pressure; that the thickness of the shell plates has been determined, the riveting designed for the different styles of joints to be used in putting the boiler together, the bracing arranged and its strength calculated, the next consideration will naturally be the attachments necessary to the operation of the boilers.

A steam dome, or drum, is no longer considered necessary in order to get dry steam from a boiler. That attachment is done away with by providing a dry pipe leading from the stop valve opening lengthwise, inside the boiler, and as high as possible. Its sectional area must be at least as great as the area of the stop valve opening, and through the upper side slits are cut, or holes drilled, having an aggregate area of at least the cross-section of the pipe, and they are sometimes given an aggregate area of as much as one and one-half times that. The free end of the pipe is closed.

While there are several methods and many rules for determining the size of the safety valve, any one of which may give a valve of sufficient size to relieve a given boiler of all the steam it will make when fired to its full capacity, it must, as a minimum, be of a size determined by the rules of the United States Steamboat Inspection Service. That law provides that, if loaded with a weight acting directly, or through a lever, the safety valve must be given ½ square inch of area for each square foot of grate surface in the boiler, and if spring loaded, 1/3 of a square inch of area for each square foot of grate surface. If the diameter of the single valve obtained by the above rule is greater than 5 inches, two valves must be used, each having an effective area of at least one-half that of the single valve. Means, independent of the steam pressure, must be provided for raising each valve from its seat to a height equal to one-eighth the diameter of the valve opening.

The main stop valve and steam pipe should be given such size that the velocity of the flow of steam through them will not exceed 6,000 feet per minute. When there are two or more boilers, the aggregate area of their stop-valve openings should exceed the area of the main stop valve opening by about 25 percent, as should also the aggregate sectional area of the pipes connecting the different boilers to the main steam pipe. All bends should be made as long and easy as possible, and pockets, where water might accumulate, must be avoided. The inevitable expansion and contraction of the piping under change of temperature must be taken care of. Very often the bends in the branch pipes from the different boilers are considered sufficient to safely take the expansion there, but with the main steam pipe it is very seldom that the bends can safely be relied upon for that duty, and an expansion joint of some kind must be provided. When an expansion joint is used, the sections each side of the joint should be securely anchored to the deck from their further ends; that is, in such a manner that none of the thrust of expansion comes on the fittings at the ends of the section of piping in which the expansion joint is placed.

For boiler stop valves, the writer's preference would be heavy, angle, or globe valves, closing toward the boiler, and so designed that the stems can be packed when the valves are wide open. The way valves should be of a similar design, then all can be packed, whether the boilers are under steam or not.

The connections for the water columns should be ample, not less than ½ inch. Cocks, instead of valves, should be used, and placed on the boiler at each end of the pipe, and provision made for keeping the connections clear, both by blowing out and mechanically. A number of excellent devices are on the market for automatically closing the water and steam-gage glass connections when the glass breaks. The use of these devices eliminates some danger and considerable annoyance.

The surface blow should be larger than the bottom blow, and of a size sufficient to create a current toward the scum pan, when the blow-off valve is opened. The sea valve, to which this pipe connects, should be of the same size. A branch should be taken from the bottom blow pipe to the donkey pump, to be used as a suction for pumping out the boiler, so that it can be allowed to cool before emptying for cleaning. Another branch, giving the injector suction through the bottom blow should be arranged, so that the injector can be used for circulating and heating the water in the boilers before lighting fires. A drain cock should be fitted to the bottom of every boiler.

The main feed pipes should be of such diameter that the velocity of flow through them does not exceed 300 feet per minute, and for small pipes, 2 inches and under, the figure should be 200 feet per minute and less. The feed checks are best of large diameter and small lift. A stop valve should be placed between the check and the boiler. The feed water should be led by an internal feed pipe, always below the water level, to a part of the boiler where there is a decending current, or to the bottom of the boiler.

Even when mechanical draft is used, the smokestack, or funnel, should be proportioned to enable the boilers to steam at very nearly their full capacity, in case of failure or accident to the artificial draft apparatus. The smokestack is the only means of creating a draft that does not require additional apparatus and attention.

The amount of oxygen required to effect the combustion of 1 pound of carbon is 2 2/3 pounds, or 12 pounds of air. It is found in practice, however, that more than that is required to effect complete combustion, and that the quantity depends upon the nature of the draft. With artificial draft about 18 pounds of air are required per pound of coal, and with natural draft about 24 pounds. The weight of the products of combustion, with natural draft, then is, $24 + 1 = 25$ pounds per pound of coal burned on the grates, and the volume of the mixed air and products of combustion may be considered the same as that of the air supplied the furnace when at the same temperature. One pound of air, at 32 degrees F., has a volume of 12½ cubic feet, and 24 pounds, the amount necessary to consume 1 pound of coal completely, would have a volume of 300 cubic feet. At any other temperature than 32 degrees F., the volume will equal that at 32 degrees multiplied by the ratio of the absolute temperature of the new temperature to the absolute temperature of 32 degrees F., so at a temperature of, say, 500 degrees F., the volume would be $300 \times (500 + 461) \div (32 + 461) = 585$ cubic feet.

The difference in the weight of a column of outside air of the same height as the funnel above the lowest fire bars, with a cross-section equal to that of the funnel and the column of hot gases within the funnel is the measure of the force that produces the draft. Let T_{32} be the absolute temperature at 32 degrees F., T_1 the absolute temperature of the air outside the funnel, T_2 the absolute temperature of the gases inside the funnel, V_{32} the volume at 32 degrees F. of air supplied per pound of fuel burned on the grates, and H the height of the funnel in feet above the lowest grates. A cubic foot of air at 32 degrees F. weighs $1 \div 12\frac{1}{2} = .08$ pound, therefore $.08\ (T_{32} \div T_1)\ H$ equals the weight of a column of air outside the funnel of a height equal to that of the funnel, and with a cross-section of 1 square foot. The weight of a corresponding column within the funnel is

$$\left(.08 + \frac{1}{V_{32}}\right) \frac{T_{32}}{T_2} \times H = \left(.08 + \frac{1}{300}\right) \frac{T_{32}}{T_2} \times H = .0833 \frac{T_{32}}{T_2} H$$

The force of the draft, that is, the difference of pressure within and without the funnel, is measured with a water syphon gage, which is simply a glass "U" tube, used with one end open to the air, and the other connected to the funnel. In use, it is filled about half full of water, which, when the connection to the funnel is opened, shows at different levels in the two legs of the "U" tube, and so indicates the difference of pressure within and without the flue. The difference in level in the two legs, measured in inches, and expressed as "inches of water," is the common measure of the intensity of draft. A column of water 1 inch high gives a pressure of 5.203 pounds per square foot, so, if the draft pressure per square foot be multiplied by $1 \div 5.203 = .1923$, it will give the intensity of draft expressed in inches of water; that is, the intensity of draft $= h = .1923\ (.08 \times T_{32} \div T_1 - .0833 \times T_{32} \div T_2)\ H$. The draft intensity in practice varies from .3 to .6 inch of water, according to the rate of combustion and the size of the steamer, and is sufficient to burn any of the coals ordinarily used for steam-making.

T_{32} is a constant, $= 32° + 461° = 493°$ absolute temperature, so the last equation can be rewritten $H = h \div (7.585 \div T_1 - 7.897 \div T_2)$. Assume the conditions, $T_1 = 521°$, $T_2 = 861°$, which are, respectively, the absolute temperatures corresponding to 60 degrees F. and 400 degrees F., and that a draft of .4 inch of water is required, then $H = .40 \div (7.585 \div 521 - 7.897 \div 861) = 74.21$ feet, which is the height that must be given a funnel to produce a draft of .40 inch.

Considering the cross-section of the funnel, it is evident that it should not be less than the total cross-section of all the tubes of all the boilers connected to it, as a contraction of the stream of hot gases, after leaving the tubes, could not be otherwise than detrimental to the draft.

It is generally stated that the power of a chimney to produce draft varies as the square root of the height, or, as one writer states it: (Holmes—*The Steam Engine*) "Then, since 1 cubic foot of air at 32 degrees F., or T_{32}, weighs $1 \div 12\frac{1}{2} = .08$ pound, therefore $H\ (.08 \times T_{32} \div T_1)$ is the weight in pounds of a column of outside air of the height of the chimney standing on an area of 1 square foot. The corresponding volume within the chimney weighs $H\ (.08 + 1/V_{32})\ T_{32} \div T_2$ pounds, and the difference between these two weights is the pressure in pounds per square foot of chimney section which produces the draft. A column of hot gas equal in weight to this difference is called the head of the chimney, and, just as in hydraulics, the velocity of discharge of water from a full vertical pipe is proportional to the square root of the height of the pipe, so in the case of a chimney, the velocity with which the air would flow, if unimpeded, into the bottom of the chimney, is also proportional to the square root of the height of the head. The height of the head, reckoned in feet of hot gas, is found by dividing the weight of a column of external air as high as the chimney, as found above, by the weight of 1 cubic foot of the hot gas. (This gives the height of a column of hot gas weighing as much as the column of external air.) If we subtract from this the height of the chimney, the difference is the height of the head."

The motion of the hot gases up the funnel may or may not be accelerated; however, it is reasonable to conclude that the retardation, due to gravity, loss of temperature and friction inside the funnel of the upward moving volume of heated gas, is compensated by the constant pressure or positive accelerating force maintained in the ash-pit, and that, therefore, the motion is uniform. The total pressure maintained in the ash-pit to force the air through the grates and the mass of fuel upon them, is the difference in weight of two volumes of gas equal to the volume of the funnel; that outside the funnel at an absolute temperature T_1, and that inside the funnel at an absolute temperature T_2. The draft may then be said to be of a certain pressure per square foot of grate area, so, if the two volumes of gas under consideration do not change; that is, if the volume of the funnel is kept constant, the total pressure to produce draft is not changed, and the draft pressure per square foot will, with equal grate areas, also remain unchanged, and consequently the rate of combustion will remain the same. Hence, it follows that the height of a funnel may be decreased and its cross area increased without changing the draft pressure per square foot of grate surface, so long as the volume is kept constant. As it would be detrimental to the draft to make of all the tubes of all the boilers connected to it, the unit in designing a funnel may then be taken to be that one having a cross-section and height sufficient to give the desired force the sectional area of the funnel less than the sectional area of draft, then, if it is desired to use a shorter stack and not change the force of draft and the rate of combustion, the height may be reduced to a minimum, keeping the volume constant.

There seems to be some advantage gained in making the sectional area of the funnel greater than the cross area of all the tubes of all the boilers connected to it, and, at the same time, so reducing the height as to maintain the condition of constant volume. The maximum sectional area that can advantageously be assigned to a funnel would appear to be that equal to the net area for draft through the grates and the mass of fuel upon them. The corresponding height, keeping the volume constant, would then be the minimum.

Suppose that the desired force of draft is .40 inch of water, and that the boilers connected with the funnel have a total grate area of 200 square feet, and that the sectional area of all the tubes of all the boilers is equal to one-sixth of the total grate area, or 33.33 square feet, which is also the sectional area of the stack to be used as a unit, so its diameter will be 6.52 feet. The necessary height of chimney to produce a draft of .40 inch, assuming that the mean temperature of the gases inside the stack is 400 degrees F., was found to be 74.21 feet, so the volume of any chimney to maintain the required draft must never be less than $74.21 \times 33.33 = 2,474$ cubic feet. The area of grates is 200 square feet, and the area of the openings between the bars will be about one-half of this, and the area for the passage of air through the mass of fuel on the grates will be about one-half of that, so the greatest sectional area that should be given the stack is $200 \times .5 \times .5 = 50$ square feet, which would make the minimum height $2,474 \div 50 = 49.48$ feet; that is, the stack should be given that height above the lowest grates, and a diameter of 7.98 feet.

If it is considered that a higher stack, say 65 feet, would keep the decks more free of cinders and present a better appearance, then it should be given a sectional area of $2,474 \div 65 = 38.06$ square feet, and its diameter would be about 7 feet. A draft of .40 inch of water is sufficient to burn ordinary steam coal at the rate of about 18½ pounds per hour per square foot of grate surface, and a stack 65 feet high and 7 feet in diameter is large enough to furnish sufficient draft to burn coal at the rate of 18½ pounds per hour per square foot on the grates of boilers having a total grate area of 200 square feet, an area sufficient for boilers supplying steam to a triple-expansion engine of 2,000 indicated horsepower.

The smokestack as designed has a volume of $2,474 \div 200 = 12.37$ cubic feet per square foot of grate of all the boilers connected to it. It has been stated that the unit to be used in designing a smokestack is that one having a sectional area equal to the area for draft through all the tubes of all the boilers connected to it, and a height sufficient to give the desired force of draft. That height having been obtained, the necessary volume of stack has been determined, and the height and diameter can be varied, keeping the volume constant, to suit the conditions of appearance, etc.

In the case considered above, the ratio of the grate surface to the area for draft through the tubes, which area is called the calorimeter of a boiler, was taken to be 6 to 1, but in practice this ratio varies from 5 to 8, so it is seen that boilers having the same grate areas, but different calorimeters, would have different sizes of funnels if the above method was followed exactly. The power of a boiler is principally fixed by its ability to burn coal, so, if the grate is of ample size, and the smokestack of sufficient height and sectional area, the principal remaining factor affecting the boiler's ability to burn coal is the area for draft through the tubes. Ratios of grate surface to calorimeter of 6 and 7 to 1 are very common; better results being obtained with the lower ratio, so it is assumed that, in all cases, the ratio is 6 to 1, then the unit volume of smokestack will be $H \times (G.\ S. \div 6)$ cubic feet, where $G.\ S.$ is the grate area in square feet. The volume of the funnel per square foot of grate will be $H \times (G.\ S. \div 6) \div G.\ S. = H/6$ cubic feet, and the following table is calculated from the equation $H = h \div (7.585 \div T_1 - 7.897 \div T_2)$, assuming that the average temperature of the stack is 400 degrees F., and that the average temperature of the outside air is 60 degrees F. Taking the net area for draft through the grates and the fuel upon them to be $G.\ S. \div 4$, the least allowable height for the stack would then be two-thirds that given in the table:

h = draft in inches of water.	H = height of stack for draft, h.	Volume of stack per sq. ft. of grate.
.30	55.68	9.28
.35	64.96	10.83
.40	74.21	12.37
.45	83.52	13.92
.50	92.80	15.47
.55	102.10	17.02
.60	111.40	18.57
.65	120.70	20.12
.70	129.90	21.65
.80	148.50	24.75
.90	167.00	27.83
1.00	185.60	30.93

The height of stack is given in feet, and the volume per square foot of grate in cubic feet.

The above method will be applied to an actual case, a steamer carrying freight and passengers on the Atlantic Coast. In service, this steamer regularly, and without any approach to forcing, burns, with natural draft, between 16 and 17 pounds of coal per hour per square foot of grate surface, a rate of combustion which should be maintained with a draft pressure of .30 inch of water, so, from the table, the smokestack should be given a volume of 9.28 cubic feet per square foot of grate in the boilers. The boilers have a total grate area of 182 square feet, so the volume of the stack should be $182 \times 9.28 = 1,689$ cubic feet. Taking the sectional area to be $G.\ S./6$, gives $182/6 = 30.33$ square feet, or a diameter of 6.22 feet. The height given in the table to produce a draft of .30 inch of water is 55.68 feet. The stack would then be made 56 feet high, with a diameter of 6 feet 3 inches. The actual stack is 52 feet 4 inches high, above the lowest grates, and has a diameter of 6 feet 6 inches, which gives it a volume of 1,697 cubic feet, or 9.54 cubic feet per square foot of grate surface.

As another example, take a large, high-powered vessel with watertube boilers, having a grate surface of 1,460 square feet. This vessel burns easily, with natural draft (at a pressure of .45 inch of water) 22 pounds of coal per hour per square foot of grate. To create a draft of .45 inch requires a stack 83.52 feet high above the lowest grates, and if given a cross-section equal to $G.\ S./6$, that will be $1,460/6 = 243.33$ square feet. In this case, however, there are four stacks, so each will have a cross-section of 60.83 square feet, and a diameter of 8.80 feet. Each of the stacks would then be made 84 feet high, with a diameter of 8 feet 10 inches. The actual stacks are 90 feet high, with a diameter of 8 feet 6 inches, and a total volume per square foot of grate of 13.99 cubic feet.

Stronger draft is required to burn coals of the poorer qualities, and those that cannot be described as free burning than is necessary to obtain good results with the best grades of bituminous coal. The writer has in mind a vessel which with such coal as Pocahontas, does fairly well, but with coal of a comparatively low grade, her steaming qualities are far from satisfactory, as the draft is not sufficient. Not only it is difficult to maintain steam at anywhere near full power, but the economy is very low, even when steaming at what should be her most economical speed. As originally planned, this vessel was to have been provided with two funnels, but during her construction that was changed and only one fitted. The vessel has two boilers, each with a grate surface of 63 square feet, making a total of 126 square feet. The original plans called for two funnels, each 52 feet high, above the lowest grates, and with a clear inside diameter of 4 feet 6 inches. These dimensions would have provided a funnel volume of 13.13 cubic feet per square foot of grate surface, which, it is seen by referring to the above table, should give a draft pressure of .42 inch of water, a force of draft ample for burning any of the coals ordinarily used for steaming. As built, the vessel was provided with one funnel 52 feet high, above the lowest grates and 4 feet 10 inches in diameter. These dimensions provide 7.74 cubic feet of funnel volume per square foot of grate area, which should create a draft pressure of .25 inch of water. This is not sufficient to get the best results, even from the best grades of bituminous coal. The ratio of stack volume to grate area should never be such that the resulting draft pressure is below .30 inch of water, even when the best free-burning bituminous coal is to be used, and for the average coals a proportion that will produce a draft pressure of about .40 inch of water should be given to insure good results.

Considerations affecting the rate of combustion are the length of grates and the sectional area for draft below the grate bars. With short grates the fires can be worked better and with less labor, and the grates can easily be kept uniformly covered with fuel. With long grates, 6 feet and over, the fire is liable to burn into holes at the back end and permit an inrush of cold air, which deprives the other parts of the fire of their proportion of air and reduces the efficiency of the furnace. With short bars, the higher efficiency of furnace obtained is due, to a great extent, to the greater supply of air per square foot of grate admitted below the bars; that is, with a given diameter of furnace, the area at the mouth of the ash-pit is the same, whatever the length of the bars may be. It is sometimes stated that "the consumption of coal is very nearly proportional to the diameter of furnace," a statement that practice seems to verify.

SHOP SYMBOLS.

BY JAMES CROMBIE.

The subject of shop marks, or symbols, has always been a burning question to the boiler maker who is moving around from place to place. The layerout, after he has spaced all holes, etc., usually places some marks of identification on the plates or sheets. What these marks indicate is known only to the layerout, and they are usually dictated by his own faculty of imagination. When the sheets (it may be of a marine or locomotive type boiler or tank or stack) are going through the different shop operations, such as punching, drilling, beveling, scarfing, rolling, etc., the man in the shop has to go and interview the layerout or the foreman and find out what is actually required and what the marks on the plate or sheet represent. If the man is long enough in this particular shop, he begins to know all these marks and what operation is required by a certain mark or symbol. Should he change into another shop he will find either another set of shop marks or marks similar to those used in his previous place of employment, but signifying an entirely different operation. The result is that he may be in a hurry, and having in mind the marks he is already familiar with, takes it for granted that these marks stand for the same thing in the present shop, and he makes some great errors, even if he does not spoil the sheet.

The reader will understand that this little article is intended for the apprentices and not for the old hand who has been bit several times and is somewhat shy in going ahead until he knows exactly what the foreman requires. But it would be a good thing for all if we could have the same symbols in every shop, and have a few blue prints made showing the symbols and what they represent, these blue prints to be hung up in convenient places so that the men could readily see them and know what was required.

It would eventually mean a great saving of time and would tend towards a better understanding in the shop. The writer proposes to show a few of the many shop marks which he has seen used to signify the simpler operations in the shop. The present-day tendency is to use white lead, and paint distinctly on the sheet what is required, and this is the better plan.

In heavy work, as in the shell plates for a large marine boiler, the plate would be laid out with the outside of the plate up; that is, the convex side when rolled. This should show the tensile strength, maker's name, etc., and the plate would then be laid out, and at the ends or butt two small center punch marks near the corner would tell the planer to plane square for a butt joint, and split these center punch marks. Another mark used to indicate plane square is a right angle painted at the end of the plate, as shown in Fig. 3. Center punch marks, arrow shape (Fig. 7), point to the position of the butt of the next course. A ring of white paint around certain

SHOP SYMBOLS AND WHAT THEY INDICATE.

holes would mean that the holes so marked would be drilled small (say 1 1/16 inches) previous to rolling plate; these holes to be used as tack holes for bolting courses together and afterwards reamed out full size (say 1 5/16 or 1¼ inches diameter). This, of course, is when holes have to be drilled in place.

The symbol shown in Fig. 9 painted on the plate would mean turn over the plate and roll up in the direction the words read. That shown in Fig. 8 would mean to roll up the plate the way it was marked and the way the word read. If only part of the plate was to be rolled and part left flat the rolling line would be indicated by a waving line and the word roll (Fig. 10).

If rivets have to be left out of the butt strap for the staybolts in a wing fire-box, a ring of center punch marks should be placed around the holes (Fig. 16), indicating not to be riveted. The mark shown in Fig. 15 around any of the rivet holes after the work is assembled for riveting would signify that the holes within the ring were countersunk *inside the boiler*, and the riveter would then know to change the inside rivet die and drive a flush rivet inside the boiler. A ring around rivet holes is often used, and indicates to the radial drill hand that the holes so marked have to be countersunk.

It is the custom in a number of shops to use center punch marks as symbols; different numbers of center punch marks denoting different operations. The writer does not favor this method of indicating a shop operation, it is a commendable act to put center punch marks on all lines so that they can be readily renewed in their proper place should they become indistinct; but boys, fooling around, may easily add one or two center punch marks to the number you have already placed on the line and so destroy the meaning attached to your mark. For instance, five center punch marks in a straight line are sometimes used to indicate a cutting line, the same will indicate a center line. The sure way with any cutting line, no matter what shape, is to shade the part to be cut out or cut off, as shown in Fig. 11.

Shading the line in this way may seem useless work, but the writer recollects an instance where this little matter, if it had been the shop practice, would have saved a lot of expense. The layerout had placed a dome flange on a large shell; he then took his crayon and marked the outside edge of the flange on the shell; he was called away, and the shell was left with the outline of the dome flange marked upon it, other pressing matters engaging the young man's attention. Eventually the shell was placed in the drill, and this piece was drilled out, the hole, when cleaned out, being so large that the flange passed through.

Five center punch marks, arranged diamond shaped, are sometimes used to denote a bending line. Five center punch marks diamond shaped are used in every shop to signify a hole to be drilled.

Three or four lines criss-cross usually indicate bevel this side. See Fig. 1. An obtuse angle, Fig. 2, indicates bevel upside down.

Where lap joints are used the outer plate should be marked with a very distinctive mark; sometimes criss-cross lines are used, but it is so easy to get confused in the number of lines. A five-pointed star within a circle, Fig. 5, is often used to indicate an outside lap. This symbol cannot be mistaken for anything else.

For the large end of a tapered piece the best symbol is a ring with the letter *B* in white paint (see Fig. 6).

A scarf is indicated by lines drawn the way the plate should be thinned out and as far along as required. If the sheets are required drawn or scarfed both ways the lines are drawn towards the corner of the sheet; but this style of scarf is not often required in boiler work.

Where ¾-inch pipe holes are required for scum cocks and water-glass cocks, a triangle painted around the hole is often used to indicate ¾-inch pipe tap or 15/16-inch hole, as shown in Fig. 13. For wash-out plugs use a square around the hole, as shown in Fig. 12.

In hand flanging the flange is indicated by center punch marks, 2½ inches to 3 inches apart. Machine flanging is also marked with center punch marks 6 inches to 9 inches apart.

Where complete formers are used no center punch marks are required, the plate being set to guides on the disc or formers.

The accompanying sketch shows a rough draft of shop symbols and what they indicate. This could be extended and other marks added according to the nature of the work going through the shop, or to the possible chance of confusion in any job where stay-bolts and rivet holes intermingle. A strip of white paint along a line of rivet holes running through rows of stay-bolts will readily attract the attention of the riveter. The distance from the plate edge to the center of the rivet hole should be plainly marked, also the size of holes, and the job number or order number, and the number required. This whole scheme could be still further simplified by having those symbols which pertain to riveting hung up near the riveting machine; the same applies to drilling or other machines, so that they could be readily referred to.

PITTING OF MARINE BOILERS.

In a former issue something has been said about boiler corrosion and its causes. The writer wishes to call attention again to the fact that the pitting of a boiler is one of the most troublesome mishaps an engineer may meet, as it generally will not stop entirely, even after all remedies have been tried.

The main causes of pitting are: air, sea water, oil and grease, pumped into the boiler with the feed water, and galvanic action. Sometimes rather strong acids are found in the boiling water. In one case known to the writer, the boiler water was taken in near a chemical factory, where strong waste acids were discharged into the river.

As a general rule the feed pumps of marine engines are much too large for their work, and it is a common rule to have the volume of the pump from two to three times the quantity of the condensed steam. But if the pump is too large, with every stroke a large quantity of air will be pumped into the boiler and the oxygen of this may attack the boiler plates. Where Weir's pumps are in use in connection with a Weir feed heater, it is not possible that any air may be discharged into the boiler by them, as the pumps stop if there is no feed water in the feed heater. But often boilers are found which show no pitting at all, even after several years' running, and without any means provided to keep the air out of the feed water.

The oil, which is used for lubrication of the cylinders, slide valve, piston rods and valve spindles, also finds its way into the boiler with the feed water, and with the high steam pressures and temperatures at which modern marine engines are worked, the oil is split up in the boiler and thereby fatty acids are formed, which may do much harm to the boiler plates. Therefore it is necessary to give to the engines and the rods as little oil as possible.

Sea water contains acids by which pitting may be caused, But with a new, clean boiler, it is strongly advised to feed salt water into the boiler during a short time to get a thin coating of scale on the inside of the plates, as this acts as a protection from the influence of the oxygen and acids which the boiler water may contain. The writer knows a large transatlantic tug company which always fills its new boilers with fresh water, and then keeps the boat moored for 24 hours, the engine running half speed, and the boiler using sea water for feeding. Thus the thin coating is formed, so that there is no danger of pitting, nor of the bulging of the flat plates and the crowns of the furnace. Especially is this danger prevalent in new boilers, as on the trial trips plenty of oil is always given to the engine, which subsequently may lodge on a plate in the boiler, so that it is overheated there and may bulge.

Galvanic action may also often cause pitting, and the only means to counteract its action is to place zinc slabs in the boiler. Such an action is only possible when the boiler water is an acid solution. Steel, with zinc in an acid, becomes electro-negative; the zinc, positive. At the zinc pole oxygen is liberated, which oxides the zinc. At the steel pole, hydrogen is liberated, which, with the oxygen dissolved in the water, forms water again. The zinc thus attracts the oxygen from the boiler plates, but the zinc and steel must be in perfect metallic contact.

A further cause of pitting is formed by the very small copper particles which are taken up in the feed water and pumped with it into the boiler. These particles come from the internal feed and scum pipes, the condenser tubes, the pump lines and the feed-pump valves, and from the copper, salts are formed in the boiler, which may attack the plates. Therefore it is recommended never to use copper internal pipes. Mr. Y. MacFarlane Gray (N. A. 1861, Vol. ii., p. 157) has detected copper specks at the bottom of pit holes, and attributed pitting to that cause. The condenser tubes are usually tinned outside, so that no copper particles can be taken from them by the feed water. But the tin particles may now be carried over to the boiler by the water, and it is believed that the corroding influence of these is even stronger than that of the copper particles.

The boiler of the government coast steamer *S* showed pitting after one and a half years' service. It was thought by the engineer that perhaps too much salt water had been supplied, and therefore more care was taken to fill the tanks up entirely with fresh water, which was taken in on a river at some distance in the country. But after six months the boiler was opened again, and the pitting showed itself such that some means had to be supplied. In Fig. 1 the dotted lines show where the pitting occurred, viz., on the top plates of the fire-to compartment 4 of the tank. When feeding, this cock was opened, thus a part of the feed water pumped back to the tank, so that the bottom of this was always covered with water, and no air could be taken in by the feed pumps. By regulating this cock, compartment 4 of the tank could be kept half filled.

So most of the oil and the air were kept out of the boiler. The pit holes were filled up with common Portland cement, as corroded places are most sensible. After two months the boiler was inspected again, but the oil and air apparently were not the causes, for the pitting was still rather dangerous, and it was evident that a new boiler would be necessary, unless the pitting could be stopped. The furnaces were also pitted on both sides, as indicated in Fig. 1. The cement in the pit holes did not hold, and was all washed away. It was then thought advisable to use more soda than the engineer had applied till that time, also to supply a little salt water for boiler feeding. The pit holes were now filled with a mixture of crown tar and red lead.

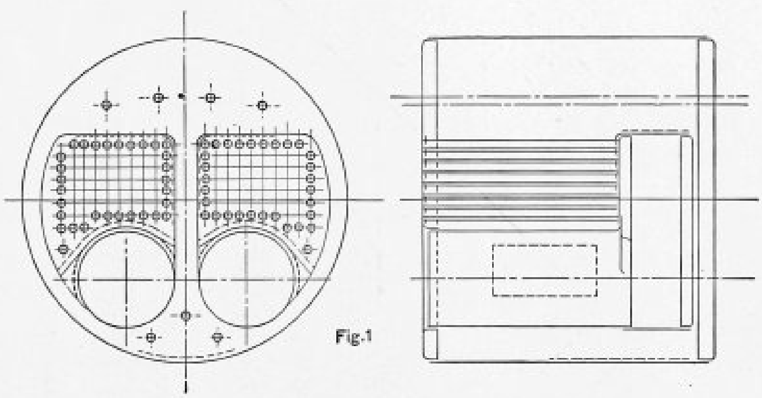


Fig. 1

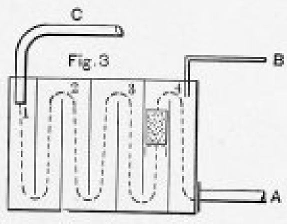


Fig. 3

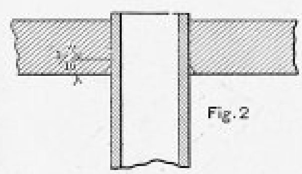


Fig. 2

A PROBLEM IN OVERCOMING PITTING.

boxes; on the bottom of the shell, and on the tube plates where the iron tubes were expanded in them. Also around the fusible plugs on the top plates the corrosion was very severe. How the tube plates corroded is indicated in Fig. 2. Nearly around all tubes along the inside of the tube nests corrosion took place, but within the nests no corrosion at all could be detected. Along the path of circulation it seems to be most severe.

The boiler makers were asked how to stop the pitting, and they recommended first, to keep oil and air out of the boiler as much as possible. Therefore a tank was made as indicated in Fig. 3. *C* is a pipe from the hot well, and the condensed steam at the engine is pumped by the air pump into the tank. Therein the water is led up and down, the oil in the meantime being mostly separated from the water. In compartment 4 a case with fine coke was placed, with a perforated bottom. Much oil was found floating on the water in compartment 1; less in compartments 2 and 3, and in compartment 4 scarcely any oil was visible. *A* is the feed-pump suction, thus much oil, which was formerly pumped into the boiler, was now left in the feed tank. In the delivery-valve case of the feed pump a cock was placed, and a pipe *B* led from this cock

As the engineer had strong objections against the use of salt water, he tried the former means. After two months the boiler was opened and the interior found in good condition. The boiler plates were all covered with a very thin coating; the pit holes were still covered with the mixture, and no black strips indicating the pitting places could be detected. The boiler was therefore saved, and it was expected that a large quantity of soda would be taken on board. But this was not done, for the chief of the service for which the boat had been built could not believe that the use of the cheap soda would be a sure cure against the costly pitting. He thought a box containing a certain boiler compound worth $12.00 (£2/10) would do much better. So the boiler was treated with the compound. But after another two months the boiler again showed the dangerous pitting. The mixture in the pit holes had protected them against further pitting, but very many new holes had been formed.

Perhaps the manner in which the compound had been applied was not correct, but in this boiler, with this engineer, it could not protect the boiler plates. The boiler has been in use a long time now, using a generous supply of soda, and the pitting has stopped entirely.

D. K.

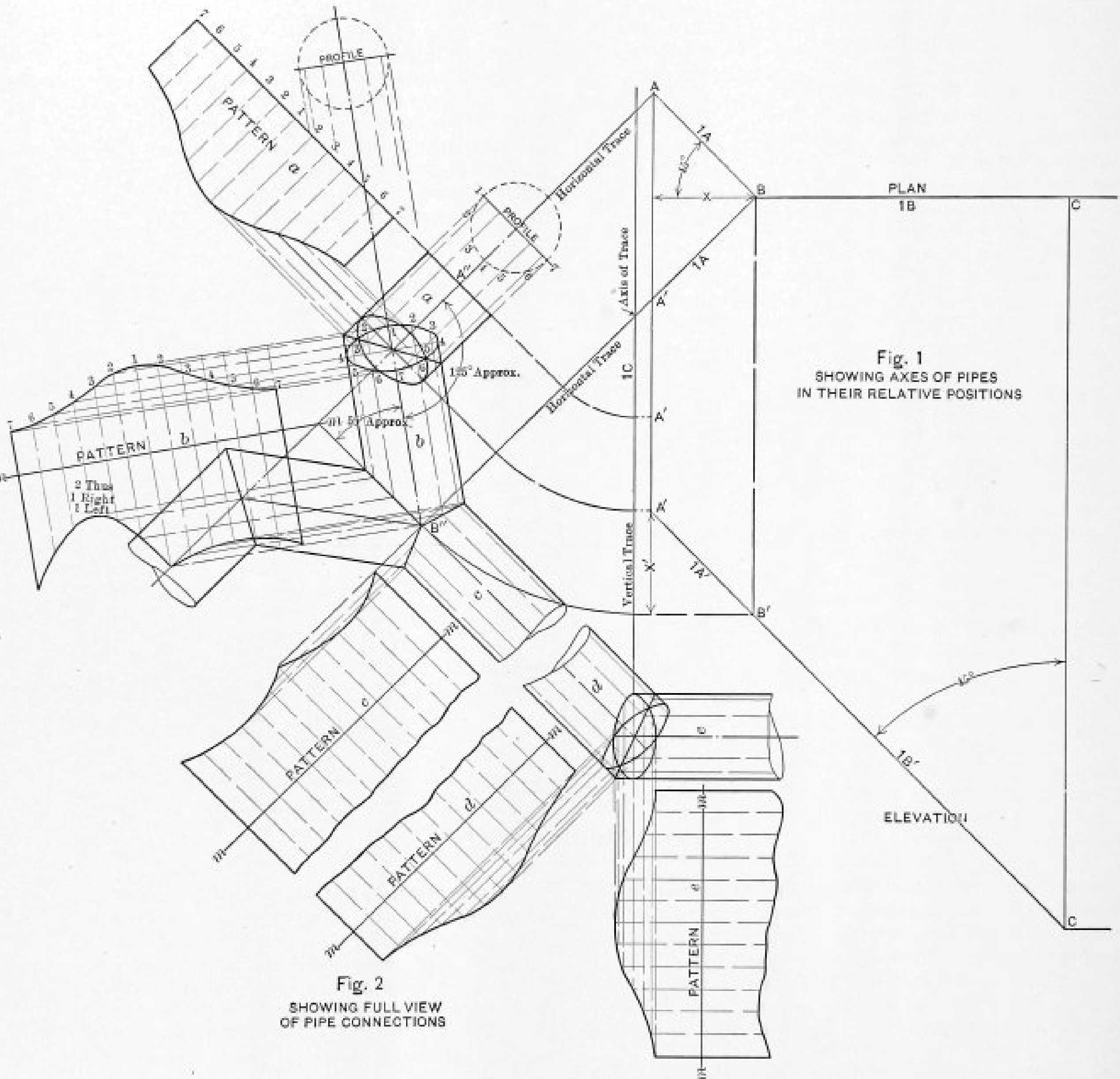
DEVELOPMENT FOR A Y PIPE CONNECTION.

BY C. B. LINSTROM.

The conditions entering into this construction cover a variety of pipe arrangements. Fig. 1 shows the axes of the pipes in question, and in both views, plan and elevation the axes are shown foreshortened. For convenience in the matter of drawing it was deemed sufficient to show the construction or arrangement in this manner.

1 *B* lie in the same plane, which is 45 degrees to either the vertical or horizontal plane of projection.

Vertical pipes intersect the Y at its extremities. The angle between the vertical pipes and the legs of the Y branch is not 135 degrees, as one may suppose. A further study and a correct solution of the problem will prove conclusively that the angle of inclination changes between the limits of 135 and 90 degrees, depending upon the angle the legs of the Y make with the axis of the pipe 1 *B*. In order to make this point



DEVELOPMENT OF THE CONNECTION, GRAPHICAL METHOD.

The requirements of this problem are to lay out all patterns for the pipe connections, consequently it is necessary to draw Fig. 2. It may appear at first that the drawing calls for a 45 degree Y connection; that is, the two branch pipes form a Y in a full view at an angle of 45 degrees with the axis of the pipe 1 *B*. A further study of the problem, however, will disclose that in the plan the projectors of the Y axis show an inclination of 45 degrees with the axis of the pipe 1 *B*. Unless the conditions are clearly understood, difficulty in securing the correct construction may ensue.

The elevation, Fig. 1, shows that the Y branch and the pipe clearer, Fig. 3 is drawn. The solid lines of *a* and *b* represent a front and side view of the connection in question. The dotted lines are for demonstrating purposes, to show how the pipes are revolved in different positions. Within these bounds the angle changes according to the amount the pipe is raised or lowered.

Referring to *a*, Fig. 3, supposing one of the legs of the Y branch is revolved around to the vertical dotted position *V*. The axis of the branch is then in the same position as the axis of the pipe 1 *B*. The vertical pipe then makes an angle of 135 degrees with the pipe 1 *B*. Referring to Fig. 3, *c* represents a side view of this connection and d the front or plan view.

Revolving the pipes around to the dotted position W, the construction will then be entirely different, as the vertical pipe makes a connection at an angle of 90 degrees with the branch of the Y. From the above it is obvious that in raising or lowering the Y, which is simply turning the pipe upon the axis O, governs the angle between the two connections 1 C and 1 A. Any position of the pipes within the bounds of V and W will necessitate the drawing of a full view for its correct solution, as the pipes within this limit are not shown in their true length. There are three methods which can be used for obtaining the correct angles between the pipes, two of which are graphical, while the other involves the principles of trigonometry.

Figs. 2 and 4 represent the graphical solution, and Fig. 5 the principles of mathematics. Fig. 4 is practically the same in principle as Fig. 2, the difference being wholly in the matter of determining the true length of line or axis of the Y branch 1 A. In construction, Fig. 4 is simpler, as it does not involve the drawing of so many lines. It is also more practical, as in some instances the dimensions of the pipe arrangement may be so great that it would be impossible to lay the problem out on the plate.

To calculate the exact angle between the vertical pipe and the 45 degree branch, proceed as follows: Referring to Fig. 5 the tangent of the angle BAD will equal the ratio of the side opposite to the side adjacent; hence the tangent $= \frac{BD}{AB}$.

For calculation we will assume the following:

$$BD = 1$$
$$AB = 1.414$$
$$\frac{BD}{AB} = \frac{1}{1.414} = .70721.$$

The next operation is to find the angle whose tangent equals .70721. Referring to a table of natural sines, cosines, tangents, etc., we find that there is no angle given for this tangent; consequently we will have to find the angle between the next less and next greater tangent. From the table we find the tangent of the next less angle is .70717 = tangent 35° 16′. The tangent of next greater angle is .70760 = tangent 35° 17′.

Their difference is equal to .70760 — .70717 = .00043; .70721 — .70717 = .00004 equals the difference between the tangents of the two small angles. Then

$$\frac{4}{43} \times 60 = 5.5''.$$

The angle of the tangent .70721 will then equal 35° 16′ 5.5″, which is for angle A.

$$\text{Angle } D = 90° - 35° \; 16' \; 5.5'' = 54° \; 43' \; 54.5''.$$

The angle the vertical makes with the Y is then equal to 180° — 54° 43′ 54.5″ = 125° 26′ 5.5″.

For most purposes encountered in the boiler shop it will not be necessary to work as close as the above.

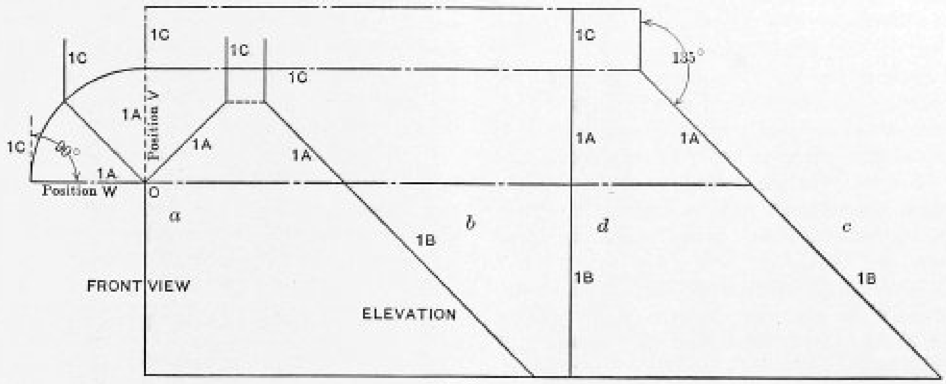


FIG. 3.

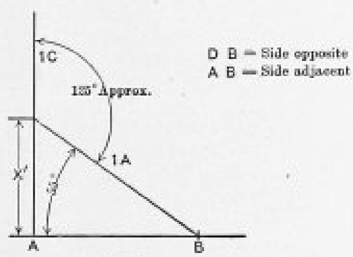


Fig. 4

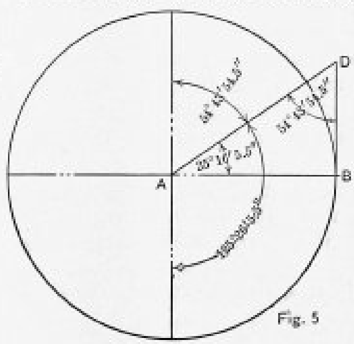


Fig. 5

DIAGRAM INDICATING MATHEMATICAL SOLUTION.

A shorter method of calculation which will answer for this purpose is as follows: Given the vertical and horizontal projection of the Y, which is equal in either case, and assuming it equal to 1, we have, according to formula, $\sqrt{1 + 1} = 1.414$, approximately.

Referring to a table of tangents, 1.414 is given as equal to the tangent of 50° 44′ approximately; 180° — 54° 44′ = 55° 16′ approximate angle in full view between branch of Y and the pipe 1 B.

Angle between vertical pipe and Y will then equal 180° — 55° 16′ = 124° 44′, which is approximately 125°.

CONSTRUCTION OF FIGS. 1 AND 2.

Proceed as follows: First draw the axes of the pipe 1 B and 1 A in the elevation to the required dimensions, project these respective sections to the plan view. At right angles to the line AB plan view draw the auxiliary planes or traces of an indefinite length. Parallel to the elevation and at any convenient distance to the left, draw the vertical trace. Where the lower horizontal trace and vertical trace intersect determines the axes of the traces which will be used for revolving the axes of the pipes 1 *A* and 1 *C* around until they are in a plane at right angles to the line of sight, and which will show the pipes in their true length and at the required angle. Referring to the drawing it will show how this view is projected. Upon the axes of the pipes draw the outer ordinates of the pipes parallel to their respective axes. Where these ordinates intersect determines the connection between the pipes. A line connecting them will be the miter line.

The connection between the vertical pipe *a*, Fig. 2, and the branch is not shown in its true position; that is, with respect to the other connections, as the pipe *a* must be swung up until the end view shows a true circle, in order to be shown in its relative position. However, for the purpose of laying out the patterns so that their connections will be correct, the pipes have been arranged so that very little confusion in their drawing will arise.

It will be noted at the pipe connections that elliptical sections are shown; these views represent the pipe in this manner when viewed from above, across the bevel. To obtain such a view simply revolve the connection around until one of the outer ordinates will be shown upon the axis of the pipe. This is done by projecting from the bevel or miter line at right angles to the axis either outside ordinate until it intersects the center line. The intermediate construction lines are then projected to their corresponding positions. It is not essential that these views should be drawn, but for bringing out the proper relationship it was thought advisable to install the foreshortened sections.

DEVELOPMENT OF PATTERNS.

At right angles to the axis of the pipes draw a stretch-out line of an indefinite length. Locate upon it the same number of equal spaces as contained in the profiles shown in Fig. 2.

Through these points draw lines at right angles to the stretch-out line *m-m*. Draw the full view parallel to the stretch-out line and project to ordinates of the pipe to their corresponding lines in the pattern. A line traced through these points of intersection determines the camber or miter line for the connection. Add for laps and space off for rivets, thus completing the layout.

Fig. 4 is simple in its construction. Draw a right-angled triangle, making the base equal to *AB* plan view, the height equal to *X'* of the elevation, the hypotenuse will be the true length of one of the legs of the Y. The angle between 1 *C* and 1 *A* is the required angle between the vertical and Y pipe, and the angle between *AB* and 1 *A* is the required one between the Y connection and the axis of the pipe 1 *B*.

Leaky Water Grates.

BY EL'GOMO

Leaky water bars and arch tubes, as applied to certain types of locomotives, are annoying. The writer had considerable experience in this respect some years ago. The water bars in many of the engines on the road gave untold trouble in the way of leakage, particularly a type where a certain rocker grate was used. Owing to length of furnace, the bars were subjected to considerable torsional strain, which in combination with the weight of the fire caused frequent renewals.

The manner of securing the ends was by threading the front ends and securing the rear ends with the tapered ferrules or by expanding with the three-point mandrel. The threading of bars was done in the machine shop by lathe hands. Now as the tail stock could not be set over to give the proper taper, it was a case of guess work, and they were sure to get enough and plenty, with poor results, as they failed to hold for more than a very short time. This same shop did the repair work and also built entirely new locomotives. The details for new work were generally talked over early enough to have things come right, and the matter of water bars was one of the details.

The method adopted to insure good results was as follows:

The threaded end of the bar or pipe was made with a slightly less taper than the tap, so as to make up tight at the end or water side. No doubt corrosion and grooving have frequently been noticed in the leg about the water bars, which was due to poor fit at the ends, allowing water to cut in about the threads. This will be found very frequently in piping jobs where taken apart.

It is the writer's opinion, based upon past experience, that better results will follow, as regards threaded joints, where the male threading tools have less taper than the female thread, standard threads notwithstanding.

THE IMPORTANCE OF CLEAN BOILERS.

At the last convention of the American Railway Master Mechanics' Association, the committee on fuel economies reported that the proper essentials of fuel economy and the conditions obtaining in a locomotive boiler on which that depends, should be as follows: A clean boiler, whose shell, tubes, sheets and stays and, in addition, crown bars in the crown-bar type of boiler, are kept free from mud and scale; properly drafted and good steaming engines; a good quality of fuel properly prepared for use; efficient operation of a locomotive; individual fuel records; a full and fair accounting. In connection with the above the opinion of Mr. M. N. Forney, one of the foremost mechanical engineers and writers of the present age, is of interest. Mr. Forney has stated that a locomotive engine consists of three parts, namely, the boiler for generating steam, the mechanism for utilizing the steam, that is, the engine proper, and the wheels, frames and springs which constitute a vehicle to enable the whole to move from place to place.

The first essential to be dealt with in considering the question of fuel economy is the boiler, or source of supply. Locomotive boilers all belong to the multi-tubular class with internal fire-boxes. At the present time, however, there are five types of boilers in general use. First, the straight tube variety. Second, the Belpaire or square wagon top. Third, the wagon top with the wide fire-box, commonly called the American type. Fourth, the extended wagon top type, used somewhat extensively on Eastern railroads, especially in the anthracite regions. Of course, the extended wagon top, with radial stayed crown sheet, probably gives the best satisfaction in general use.

The reason that it is so important that the sheets be kept free from mud and scale is that the heat given off by the burning fuels may be more readily absorbed by the water through the sheets than would otherwise be absorbed by the mud and scale, representing an absolute loss in heat and a consequent waste in fuel, with all the other evils which travel in the wake of boilers not properly taken care of, such as leaky flues, stay-bolts and fire-box sheets, etc.

The design of a locomotive boiler should be such as to give as large a heating surface, both fire-box and tubes, as possible with a large grate area, in order to provide for a slow rate of combustion. Provision should also be made for a good, free circulation of the water, and also to see that flanges are properly turned, so that no traps are formed for the accumulation of dirt and scale. The care of the boiler should be closely looked after, both as to the proper blowing out at terminals and on the road during every trip. This, together with a good showing at the terminals, and proper care in their handling, will extend their life and usefulness and materially aid fuel economy. The study and attention now given to locomotive boiler design, as compared with that of some years ago, is marvelous.

The care given to locomotive boilers in service of all railroad companies will undoubtedly materially assist in the promotion of fuel economy.

As to the drafting of engines; it is a fact that one of the greatest sources of trouble on many railroads to-day is the improper drafting of engines. It, therefore, goes without saying that this matter is entitled to and requires constant and close supervision and attention, since a slight defect in the draft apparatus, which might easily escape notice, is likely to occasion a large waste of fuel.

Insufficient draft might be caused in a number of ways. First, in the fire-box by the grates being clinkered. Second, by the heat of the fire not being fully utilized by the engine crew not being educated up to a point of appreciating the importance of the subject, or through their neglect of the proper essentials of fuel economy in the performance of their work. Third, through a lack of the proper vacuum being formed in the front end, or smoke-box, by the exhaust steam. The proper remedy can and must be applied if a thorough investigation of the subject has located the difficulty.

Concerning draft appliances, it is only necessary to point out that the master mechanics' standard, if strictly adhered to, gives most satisfactory results.

BOILER INSPECTION IN DETROIT.

Every city in the United States which has no adequate boiler inspection laws should carefully investigate what is being done in this regard in Detroit, Mich. According to *Power and the Engineer* two different ordinances covering boiler inspection are now under consideration by the Detroit City Council. The boiler question in this city started from a disastrous explosion which occurred at the Journal building some years ago where thirty people were killed. Following this accident an ordinance was passed for city inspection and licensing of engineers. This ordinance was based largely upon that in force in Philadelphia at the time, and proved satisfactory as a starter toward intelligent supervision of steam generating apparatus. Among other things embraced in the ordinance, however, was a clause in section 18 to the effect that no person "shall have charge of or operate a steam boiler in the City of Detroit without license"; and part of section 21, which provided that "Anyone who shall employ a person without a license to operate any boiler within the City of Detroit shall be deemed guilty of misdemeanor, and upon conviction shall be sentenced to pay a fine not exceeding $1,000 and to undergo imprisonment in the Detroit House of Correction for a term not exceeding six months." The foregoing was enacted while the public mind was inflamed over the great loss of life and property, and the ordinance was framed in a manner to indicate that explosions could be stopped by placing engineers in charge of boilers for heating, power, etc., wholly neglecting to provide for first-class materials and workmanship.

When J. C. McCabe, the present chief boiler inspector, took office in 1908, enforcement of the ordinance then in effect brought such a howl from steam users, firemen, night watchmen and others on account of the above-mentioned clause that it became imperative to amend the ordinance, and its revision has since been a leading question.

Of the two schemes proposed the Walsh ordinance is a copy of the revised Massachusetts rules in their entirety, which fixes a standard of workmanship and material. This was submitted to the last convention of American Boiler Manufacturers' Association, held at Detroit, and approved by them. The other, or Knowlton, ordinance is also based largely upon the Massachusetts rules, the principal difference being in the factors of safety adopted. Adherents of the Knowlton ordinance, claiming the endorsement of the Manufacturers' Association of Detroit, hold that a strict interpretation of the Massachusetts rules to the city of Detroit would condemn hundreds of boilers and impose unnecessary hardship on steam users, and that their ordinance has been framed to meet in the best possible manner the existing local conditions. In lieu of the Massachusetts rules they provide a factor of safety of 4 for boilers carrying pressures not exceeding 100 pounds gage pressure per square inch; 4.5 for boilers carrying pressures not exceeding 125 pounds gage pressure per square inch; 5 for boilers carrying pressures not exceeding 150 pounds gage pressure per square inch, and 6 for all boilers carrying pressures over 150 pounds and not exceeding 200 pounds gage pressure per square inch.

Those advocating the Walsh ordinance point out that these factors of safety unduly favor old boilers, which ought ordinarily to be progressively reduced in pressure according to age, and in addition to this operate to the disadvantage of new installations; for instance, a boiler is cited at the plant of the Detroit Dry Dock Company thirty-seven years old and built of iron plates, the bursting pressure of which is calculated at 318 pounds. Under the present ordinance, with a factor of 4.5, 70 pounds is allowed on the boiler. Under the Knowlton factor of 4, 79 pounds would be allowed, while according to the revised Massachusetts rules, with a factor of 6, only 53 pounds could be carried. On the other hand, on twenty-five boilers at the plant of the Detroit Edison Company, with a bursting pressure of 1,154 pounds, the Knowlton ordinance, using a factor of safety of 6, would allow 190 pounds boiler pressure, while the Massachusetts rules, using a factor of 4.5, give 254 pounds.

The present administration has collected a great number of interesting data in regard to the boilers installed in the city of Detroit. According to this list there are 1,673 boilers in use aggregating a total horsepower of 170,354. There are 271 boilers of unknown age, three of the oldest known being 37 years of age. It was discovered that one boiler used for heating had been in use for two years without a safety valve, and in completing the list 700 boilers were found which had never been listed nor had any regular examination. From the data collected it appears that 60 boilers, aggregating 24,221 horsepower, and ranging from 1 month to 14 years of age, would be reduced materially in pressure by the enforcement of the Knowlton ordinance, while the effect of the Massachusetts rules would be to reduce the pressure on a total of 67 boilers with a nominal horsepower of 7,762, these boilers running between 19 and 37 years old.

The question is now being carefully considered by the City Council, and it is expected that a decision in regard to the rules will soon be made.

The situation in Detroit is undoubtedly similar to that in many other cities in the United States, and now that this matter is being so thoroughly investigated in Detroit, other cities should take advantage of the results of the investigations and deliberations. The promulgation of the Massachusetts rules has had a great influence towards arousing the public to a realization of the necessity of better inspection laws and to the proper requirements of such laws, and it is to be hoped that the good example set by Detroit will have a similar effect. Boiler inspection is a matter that should be provided for by the State, but failing that much benefit will result from adequate municipal boiler inspection laws.

BOILER REPAIRS BY ELECTRIC AND AUTOGENOUS WELDING.*

BY A. SCOTT YOUNGER, B. SC.

ELECTRIC WELDING.

In the spring of last year the author visited Gothenburg with the object of investigating and reporting upon the Swedish electric welding process invented and patented by Mr. O. Kjellberg, and it is now proposed to describe the apparatus and method of using the same, and also to give illustrations of boiler and other repairs which have been carried out. Some of these repairs were seen in operation, and several of the repaired boilers were personally surveyed. A paper was read on this subject in regard to boiler repairs by Mr. H. Ruck-Keene before the Institute of Marine Engineers, in September, 1907, in which several excellent illustrations were given, some of which are also here reproduced.

As is well known there are many methods of so-called electric welding, which are divisible into two classes, viz.: resistance welding and arc welding. The former method is that employed in the machines and apparatus used for welding pipes, chain links, tramway rails and other purposes. These

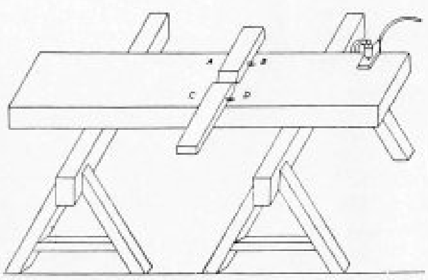


FIG. 1.

machines usually form some modification of the welding apparatus designed by Thomson in 1886. Arc welding is an older process, having been used in 1881. The work piece was connected with one pole of a source of current capable of maintaining an electric arc. The other pole was a carbon rod, held in a suitable insulated holder, directed by the operator so as first to make contact with the work piece, and then the proper separation was effected so as to maintain the arc. A modification of this method employs a metal electrode in place of the carbon rod.

The arc method is essentially a fusing process, and has been found applicable in special cases for filling defective spots in iron or steel castings, by fusing into blow holes or other spaces small pieces of similar metal, added gradually, and melted into union with the body of the piece by the heat of the arc. This use of it is well known in this district.

All welding with carbon electrodes is liable to give material too hard, as particles of the carbon are absorbed by the molten iron, and this, in conjunction with other practical difficulties, has prevented much progress from being made along these lines.

These difficulties, however, have been overcome by Mr. O. Kjellberg, whose apparatus for arc welding has given most excellent results and has led to the formation of three separate welding companies in different districts of Sweden. One of these has its headquarters at Gothenburg, where many of the repairs to be described were carried out.

In arranging for his visit, the author asked Mr. Kjellberg if his company would weld up a pitted or defective plate cut out of an old boiler, and while this was readily agreed to, it was stipulated that the plate would have to be sent over to the works, as Mr. Kjellberg said: "A pitted boiler plate is not to be found in any yard on the river, as we now mend all pitted boiler plates in place by our process."

This difficulty was got over by getting a number of test pieces to represent defective plates repaired by this process and testing them against the original plate. The pieces were

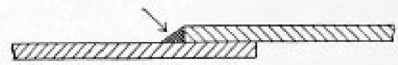


FIG. 2.

welded in the author's presence, brought back to Glasgow, and tested in one of the local steel works. The results will be given later.

The apparatus in use at Gothenburg was installed on board an old barge which could be towed alongside any steamer requiring repairs. It contained a complete welding outfit, with sufficient cable to pass on board the steamer and long enough to reach inside of the boilers if necessary. The cables were in duplicate, so that repairs could proceed at two places at the same time. The barge, or floating workshop, was about 80 feet in length by 20 feet in breadth, fitted with a small marine type of boiler, which supplies steam to a de Laval turbine driving two direct-connected dynamos and exciter, and exhausting into a jet condenser.

The turbine made 12,500 revolutions per minute, and the dynamos 1,250. The voltage could be varied from 50 to 120. At the fore end of the barge there was a workshop having an anvil and vise benches, and generally suitable for carrying out small repairs. There was also a steam-driven air compressor for supplying compressed air to pneumatic tools, which were used for preparing the surfaces for welding or dressing off after the operation.

This description of the apparatus will apply equally to the others, except that the one at Stockholm is self-propelling, and the engines which drive the propeller are disconnected on arrival, and are then used for driving the dynamos. This makes a very complete and useful arrangement.

The anvil block is a slab of steel 10½ inches wide by 2½ inches deep, laid across two wooden trestles, Fig. 1, and the negative terminal from the dynamo is clamped to it, as shown at *E*. The positive pole is the holder, and is held in the left

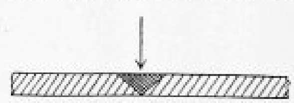


FIG. 3.

hand of the operator. The handle, of course, is insulated, and the current passes through the tongs in the jaws of which the steel rod used for welding is held. This rod is about 3/16 inch in diameter, and is specially prepared, being coated with a substance, the composition of which is secret, but which appears to be of the nature of a flux. The operator, whose right hand is free to use a hammer, must be provided with spectacles having dark colored glass.

The operation of welding one of the test pieces was as follows: The edges to be welded were chamfered, and the two pieces were then laid on the anvil block, as shown in Fig. 1, and secured in position at points *A*, *B*, *C*, *D* by welding a small part of each to the anvil block, much in the same way as one would use sealing wax on paper. This operation was very quickly performed and did not last more than a minute. The rod was then touched against the point to be welded, and on being withdrawn a suitable distance an arc was formed, producing intense light and heat. The point of the rod was raised to welding heat and pressed against the work, which had also risen to welding heat. A drop of the rod adhered, and

* From a paper on "Steamship Repairs by Electric and Autogenous Welding," read before the Institution of Engineers and Shipbuilders, in Scotland, February, 1910.

after withdrawing the rod the part was well hammered. The repetition of this process completed the welding of the test pieces, which lasted about twenty minutes. It was then roughed down by the pneumatic tools and finally machined for testing.

The description of this work has been given with some detail as it applies generally to the welding process.

The test pieces showed that the tensile strength of the re-

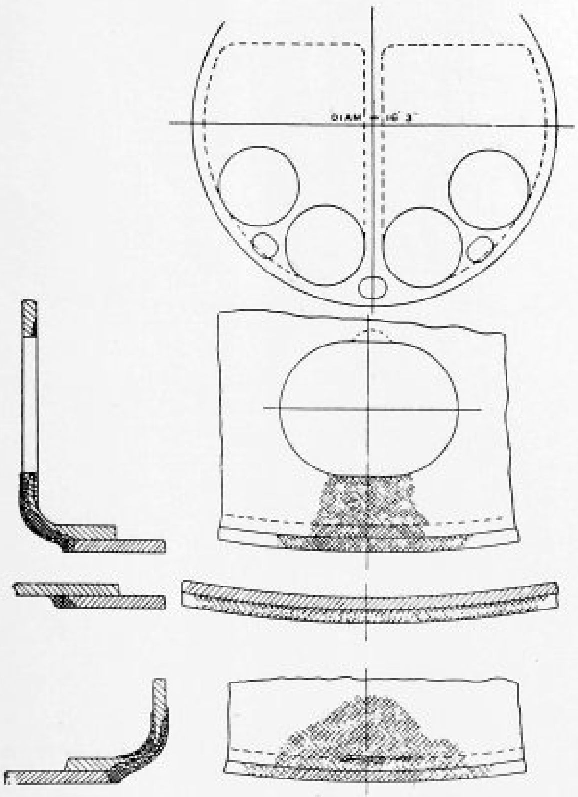


FIG. 4.

paired plate is nearly equal to the original, but the elongation is only about one-third of the original. The bending test was carried out with the treated portion on the outside of the bend, and the radius of the bend was the thickness of the plate. The test was fairly good, but the metal showed a tendency to crack similar to the unannealed sample on the table.

It was subsequently discovered that inferior material had been used in these welds, and this, no doubt, accounts for the poor elongation.

Test pieces were made by building up the entire piece by small amounts of welding metal melted by means of the arc. An interesting feature in the results is that material can be produced of varying degrees of hardness.

None of the specimens were annealed except one, and the annealing had a most marked effect in reducing the elastic and yield point stresses and increasing the elongation and contraction of area.

In building up metal on a slab or plate the welding heat is said to penetrate only .03 inch into the material, and the temperature of the arc can be regulated to suit the work from 2,000 to 4,500 degrees F., partly by apparatus connected with the dynamo and partly by the coating on the rod. Of course, the heat is gradually conducted away, but it is generated so rapidly that while a portion is at welding heat it is possible to touch the plate 3 to 4 inches away.

Some trials were made in the author's presence, and interesting results were obtained. In making good a leak between the lap of two plates, as in boiler work, it is usual to add a fillet of iron, as shown in Fig. 2. This was done at the rate of 11 inches to 2½ minutes. In butt welding the edges of the plates to be joined are chamfered, as shown in Fig. 3, and the work consists in filling up the right angled groove thus formed. A practical rate of working for a plate of ⅜ inch thick was found to be about 10 feet per hour. The current required was 13.5 kilowatts at 90 volts, and 150 amperes.

Following are illustrations of repairs effected by this method,

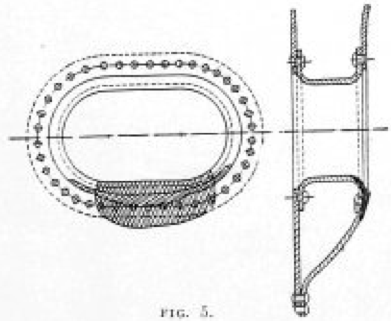


FIG. 5.

and it will be seen that a great variety of work is possible:

Several of the boilers here shown were examined after having been at regular work, in some cases over two years since the repairs were carried out. Leaky seams had been made tight, thin parts filled up, and, generally, their condition supported the claim of the welding company to have indefinitely prolonged the life of the boilers.

Fig. 4 shows repairs to the front plate of a marine boiler which was wasted by leakage in way of the manhole and lower circumferential seams. Trouble is frequently experienced by leakage in this way which often necessitates extensive repairs.

Fig. 5. This sketch illustrates repairs to the inside edge of the fire-door of a vertical donkey boiler.

Fig. 6 illustrates a part of the tube plate of a boiler. This plate was laminated, and formed a blister which cracked, owing to the heat not being conducted away. The blister was cut away, as shown, and filled up by the welding process. The lamination extended beyond the part cut out, and a number of rivets were inserted to keep the surfaces in contact.

Fig. 7. This shows the front end of the marine boiler where the lower part of the circumferential seam was level with the floor, and because badly wasted by leakage from the manhole door and damp ashes. Repairs were executed in October, 1906, and since have given entire satisfaction. The boiler carries 160 pounds pressure, and has been in constant use since.

Fig. 8 illustrates a boiler of the steamship *Alice*. This boiler is double-ended, and the furnaces were renewed as shown, and afterwards leaked badly at the back seams over the fire. The welding process was applied round the top half of these seams and the trouble effectually cured.

Fig. 9 shows a furnace of the Adamson ring type, which had

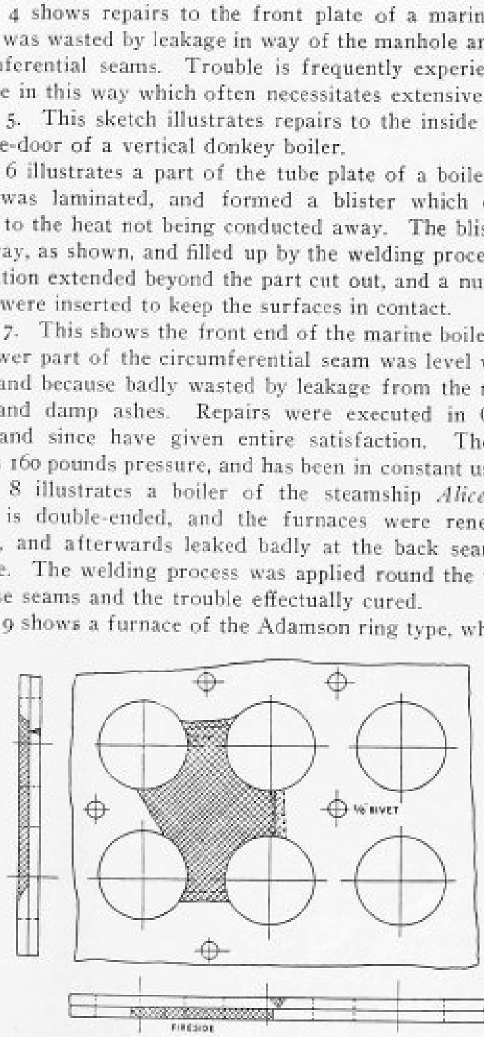


FIG. 6.

cracked, no doubt on account of overheating, due to accumulation of dirt. The cracks were repaired by screwed pins, which proved unsatisfactory, and by leaking caused corrosion of the adjoining plate. In June, 1906, these pins were removed, and the cracks filled up by welding, the adjacent thin parts being thickened at the time. The furnace has since been absolutely tight.

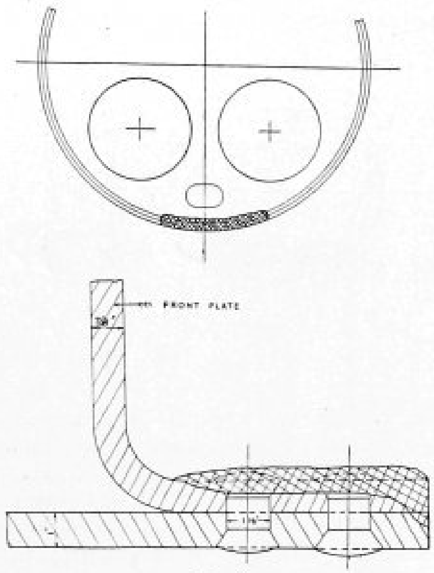


FIG. 7.

Fig. 10 shows a marine type of boiler, with two furnaces and a common combustion chamber. The back furnace seams were entirely ruined by leakage and calking. The plating round the rivets in some places was altogether gone, and several cracks extended through the furnace plate. On the left is a view of the repairs seen from the furnace, and on the right from the combustion chamber. Material was added for a distance of about half round each furnace, as shown. A patch on the bottom, which had cracked, was also welded up. This boiler was tested with hydraulic pressure to 180 pounds on completion of repairs in 1905, and has since given entire satisfaction.

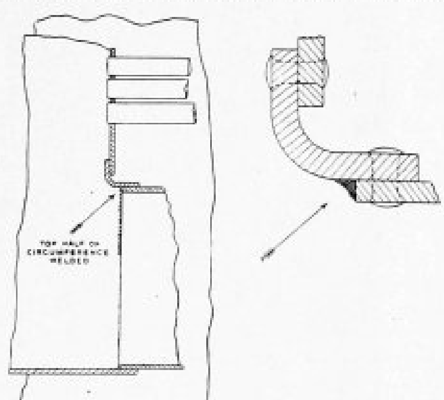


FIG. 8.

Fig. 11 shows what can be done by this method in the back end of a boiler. The illustration is that of the double-ended boilers of a well-known Swedish passenger vessel. The boilers are eighteen years old, and five or six years ago had extensive repairs carried out to the saddle plates and combustion chambers. These repairs gave trouble by leakage at the landing edges, and were then repaired by the welding process, as shown. All the edges of the patches showing leakage were dealt with, as well as many rivets and local corrosions. The length of the landing edges treated in this way was over 80 feet. Six months after completion the repairs were surveyed by the Board of Trade in London, and the boilers were tested by hydraulic pressure, and special satisfaction expressed with the work. These boilers have since been regularly examined by Lloyd's surveyors, and the repairs have given complete satisfaction.

The next two illustrations refer to repairs carried out on the original boilers of the steamship *Zelos*, a vessel twenty-

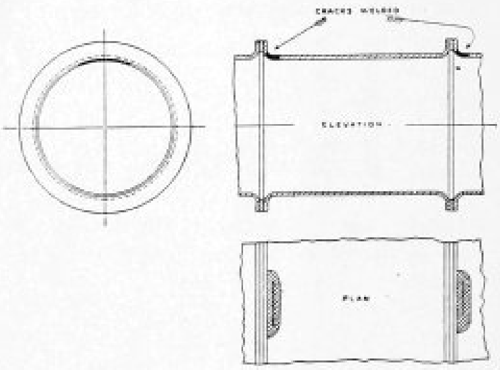


FIG. 9.

five years old. These repairs were done about three years ago, and when examined last year were found in good order, and the seams were apparently quite tight. The circumferential seams at the bottom, both back and front, had been welded, as shown. The vessel retains her class in Lloyd's *Register*.

Fig. 12 illustrates the starboard boiler front plate of the steamship *Zelos*, and Fig. 13 shows the port boiler back plate of the same vessel.

The foregoing illustrations instance some repairs to boilers, but the method can be applied to almost all other boiler repairs; cracks can be filled up in furnaces, manholes can be restored where wasted, and leaky rivets and pitted holes made good.

AUTOGENOUS WELDING.

The second method of repair to which reference has been made is the oxy-acetylene process of welding, or, as it is called, autogenous welding.

This method, as far as it applies to ship repairing, appears to have originated in Genoa, but its advantages were quickly recognized in France, and its use soon extended over the whole country. In this connection, Mr. A. le Chatelier, chief engineer of the French navy, says: "There is not in France at the

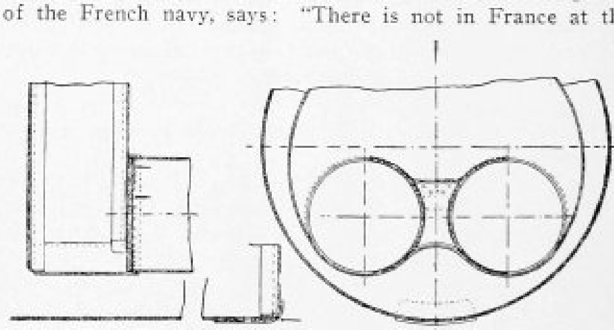


FIG. 10.

present moment a single boiler-making or mechanical engineer's workshop of any importance which does not make use of autogenous welding, and no new working process has ever found general adoption so rapidly."

Acetylene, which is represented chemically by the symbol $C_2 H_2$, is what is known as an endothermic gas, that is to say, it is one of those bodies whose formation is attended with the disappearance of heat. Such bodies are nearly always found to show considerable violence in their decomposition, as the heat of formation stored up within them is liberated as sensible heat. A great future was expected from the use of this gas, as an illuminant, as when compressed into the liquid state it occupied 1/400 of its bulk. However, several fatal accidents attended its use in this way, and the matter was carefully investigated. It was found that if liquid acetylene in a steel bottle was heated at one point by a red-hot platinum wire, the whole mass decomposed, and tremendous pressures were generated such as no cylinder could withstand. These pressures

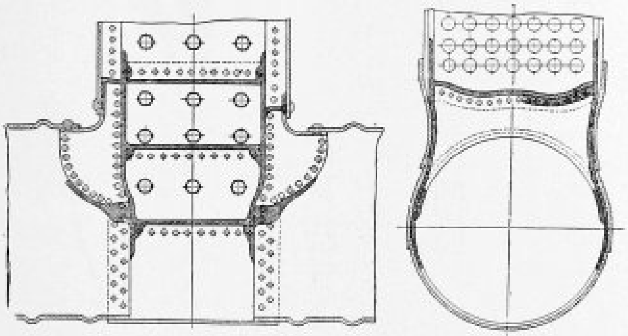


FIG. 11.

amounted to from 71,000 to 100,000 pounds per square inch. Other experiments were made, and the storage of the gas in a liquid form was found to be attended with danger, so that it is now prohibited. It is, however, readily soluble in certain liquids, of which acetone absorbs 31 times its own volume, so that a porous substance soaked in acetone and confined in a steel bottle can be used for storing it. This method of storing it has been sanctioned, and steel cylinders can be obtained which contain 10 times their own volume for every atmosphere of pressure. The usual pressure is 10 atmospheres, so that the cylinders contain 100 times their own volume.

The plant required for welding consists of a number of

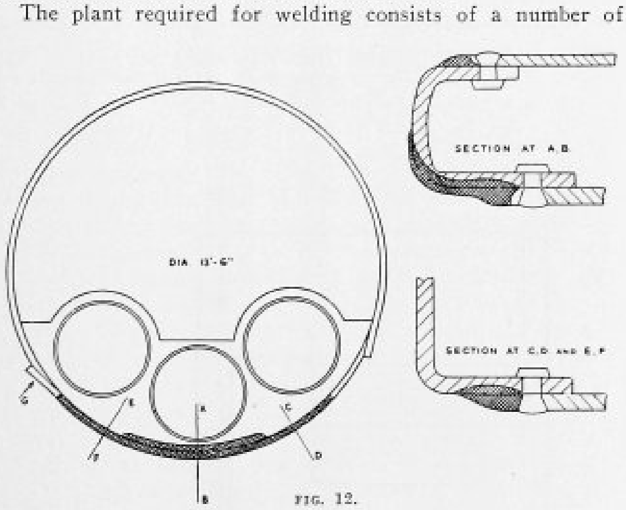


FIG. 12.

blow-pipes of different sizes and a supply of compressed oxygen and dissolved acetylene. These gases can be obtained on a commercial scale, under a pressure of about 10 atmospheres, in steel bottles with the necessary regulating apparatus, pressure gages, etc. These items, along with a supply of rubber tubing and small fittings, comprise all that is required for what is known as a high-pressure welding plant. This apparatus is used in steamship repairs, though a similar welding plant is also used in fixed installations, in which the acetylene gas is generated as required and taken at a low pressure from an ordinary gas holder.

The temperature of the oxy-acetylene flame is given as about 6,300 degrees F., which is above the dissociation temperature of steam (about 5,150 degrees F.). The result is that a zone of free hydrogen surrounds the flame at its point of highest temperature at the nozzle of the blow-pipe, and renders it suitable for many operations which would otherwise have to be carried out by more costly means.

The method of using the apparatus is as follows: The oxygen and acetylene gases are passed through the regulators and brought to the nozzle of the blow-pipe. The acetylene is first lighted and the oxygen gradually screwed on until the necessary white tip is obtained on the burner. When the

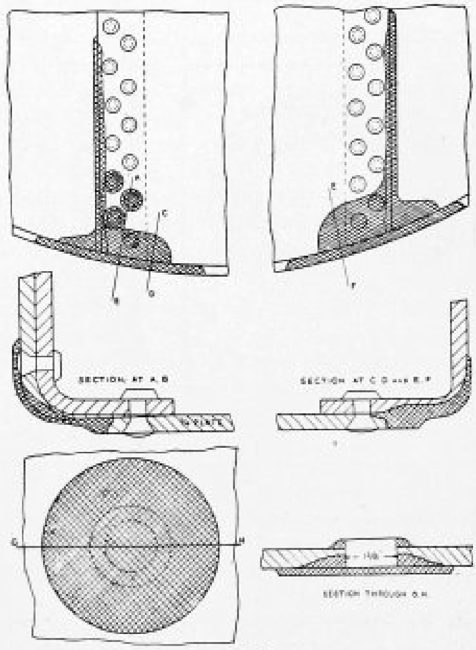


FIG. 13.

blow-pipe is working properly the flame is almost colorless, except for the white cone, which varies in size with the blow-pipe. The pressure of the acetylene gas passing to the nozzle is about 5¾ pounds per square inch.

The operator holds the blow-pipe in one hand and applies the flame to the part of the work to be welded, which is thus raised to a welding heat. In the other hand he holds a thin rod of iron or mild steel about 3/16 inch in diameter, the end of which is held in the flame and is soon fused. A drop of the metal is melted off and attached to the part under repair, and this process is continued until enough material has been added to make good the defect.

The nature of the repair requires to be carefully considered in every case, as the thickness of the plate materially influences the time required to reach welding heat. In this respect there is a great difference between the electric and the oxy-acetylene methods. In the former case it was found possible to attach the test pieces to the anvil block by welding a small spot on each side, an operation very quickly performed. In the latter case this would be impracticable, as both the test piece and the anvil block would require to be raised to welding heat.

Building up metal on a thick slab cannot be done with the oxy-acetylene method without a preliminary heating, and probably a large portion of the slab would require to be kept at welding heat.

The reason for this appears to be that although the temperature of the oxy-acetylene flame exceeds the melting point of steel, the heat is to some extent dissipated, is rapidly conducted away by the metal itself, and is also cooled by air currents, so that a heavy section being welded by this method requires the heat of a forge fire. It is not quite clear what is the precise action which goes on, but the electric arc appears to concentrate the heat at a point, whereas the effect of the acetylene flame is spread over an area.

An experiment was made by the author to test this point.

The largest size of oxy-acetylene burner was held for three minutes on the anvil block, which never reached welding heat, but the block quickly got too hot for the hand at a distance of 12 inches.

In boilers the plates are not very thick, and this method can be used to effect repairs similar to those already illustrated. The edges of the plate to be welded require, of course, to be chamfered, so as to form an open groove to the bottom of which the flame can penetrate. The results of test pieces show that the reduction in tensile strength varies from 19 percent to 40 percent, and in elongation from 57 percent to nearly 80 percent.

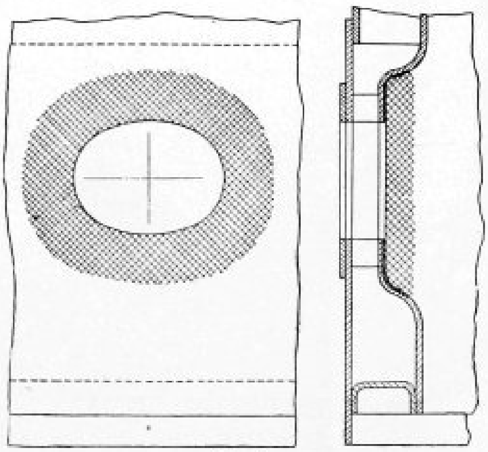


FIG. 14.

Test pieces submitted to bending tests also were unsatisfactory. Other test results have been published which are much more favorable, but it has been thought well to record those actually obtained at this time.

Many of the illustrations already given of electric welding would serve for the oxy-acetylene method, but it has been thought well to give a few cases actually carried out by the latter method.

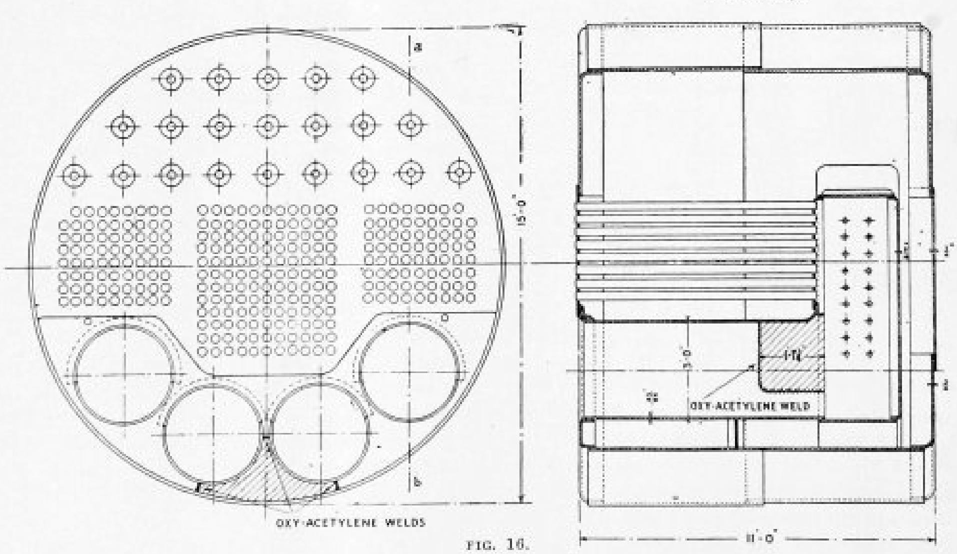


FIG. 16.

Fig. 14 shows repairs to the plate in way of the furnace door of a vertical donkey boiler. It was found that the plate, where shaded, had become very thin, due either to the original stamping of the plate or to corrosion. The oxy-acetylene method was adopted to thicken up the thin part, and was successfully applied over the whole area shown. The thickness of the plate was increased in places by nearly ⅜ inch.

Fig. 15 illustrates repairs recently carried out in this district to the main boilers of a large passenger steamer. The right-hand view is taken from the combustion chamber back looking towards the front of the boiler. It shows that the tube plate on which the flange of the furnace has been riveted has cracked in many places, and in two instances these cracks extend through the rivet holes beyond the flange of the furnace. All the cracks were first cut out by a deep V groove, which was then filled up in the way already described, and a very satisfactory job was made. In similar cases where cracks are more numerous it is sometimes found better to cut away a piece of the plate altogether and weld in a new piece.

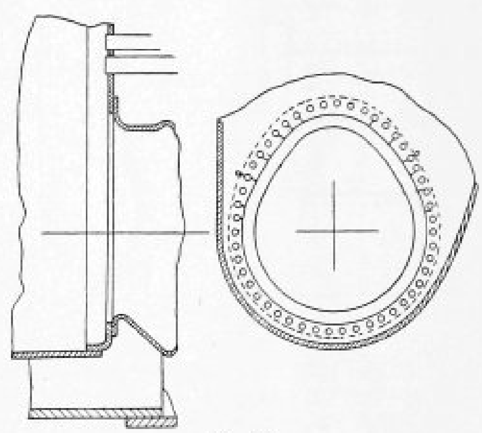


FIG. 15.

Fig. 16 shows repairs carried out to the main boilers of the steamship *Moulouya* at Marseilles, in July, 1908. A portion of the front plate and five saddle plates were renewed as indicated.

Extensive repairs are frequently carried out at Marseilles and other continental ports, which are almost startling to those hearing of them for the first time. In several cases furnaces have been renewed in which the saddle plates, being flanged up on the fire side of the tube plate, would not go through the hole on the front plate. In these cases the saddle plate was cut off the new furnace in two pieces, and welded on again after the furnace was got into position. In other cases the entire lower front plate has been cut out of the boiler and renewed by welding.

It is claimed that the oxy-acetylene method of welding restores the parts to their original condition. That this cannot be the case is evident from the fact that, the composition of the material used for welding is frequently not the same as that being welded. Again, unless very skilfully carried out the weld is not so reliable as could be wished, the material becoming very brittle and having little elongation.

Evidence of this is found in the tests in which both the tensile strength and elongation were far from satisfactory. It thus appears that this method should only be made use of in cases where the part repaired is not subject to tensile stresses, and if this rule is adhered to, there need be little hesitation in adopting it. It is, of course, absolutely necessary that the men using this process should have been carefully trained for some months before undertaking responsible work.

Comparing the two methods, it may be pointed out that the test results from the electric welding are more favorable, and, therefore, it is considered that the first-named process could be used in cases where the oxy-acetylene method would be inadmissable. Before accepting this, however, it would need to be established that the results obtained in the tests could be reproduced regularly in actual work, and this could only be the case where both the material used and the method of using it were standardized and capable of simple application.

Leaving out of account, however, those cases where the material is subject to tensile or compound stresses, there remain very many instances in steamship repairs, in which these methods could be safely and profitably used.

In many instances repairs could be carried out in a mere fraction of the time required by the older system, and the cost at the same time proportionately reduced. The enormous advantage of this to the shipowner, who loses the use of his ship while under repair, and to the shipowners and underwriters who pay the bills, will be admitted by all acquainted with steamship repairs.

EXPLOSION OF AN AGED AND DEFECTIVE SAWMILL BOILER.

One of the most disastrous and needless of the recent boiler explosions occurred Feb. 10 in a sawmill at Crump, Mich. The exploded boiler was old and defective, and was being operated under conditions which no intelligent inspector would have permitted. The accident emphasizes again the great need for State supervision over the construction and inspection of steam boilers. Accidents such as these are a disgrace to the community in which they occur, and are indicative of criminal negligence on the part of the law makers of the State, who could, by the enactment of suitable boiler inspection laws, prevent practically all such disasters. Mr. J. C. McCabe, chief boiler inspector of the city of Detroit, sends us the following synopsis of a report which he made to the State Labor Commissioner regarding the explosion:

The exploded boiler was built from a poor grade of iron, and appeared to the writer to be between thirty and forty years old. It was 54 inches in diameter and 16 feet long, and was made up of three courses of two 5/16-inch iron plates to each course. The steam dome was 24 inches in diameter and 30 inches high, and was located on the top of the second course, and 2 inches back of the girth seam joining the first and second courses. The manhole ring was made of cast iron, and was located 6 inches back of the steam dome opening. The boiler had new steel heads within recent years, and held fifty-four 3½-inch tubes. There was an old crack about 4 inches long in front of the steam dome, which has been drilled and filled with screw plugs to stop leakage.

The initial rupture occurred through this plugged crack, and ran around the flanging of the steam dome and the strip of metal between the manhole and the steam dome openings, and extended along the girth seams on the rear course, and sheared the rivets in the longitudinal seams in some places and in others the plate parted between the rivets. The whole of the middle course and lower half of the rear course opened up and lay flat on the ground where the boiler stood. In fact, the cast iron pedestal supporting the boiler in the rear was forced through the sheet by the violent reaction of the steam expanding against the atmosphere. The upper half of the rear course, with the segment of the rear head, was thrown to the rear of the boiler setting. The front course was torn from the others, and also was separated at the longitudinal seams, and the upper half was carried with the steam dome attached about 400 feet forward and to the right of its original position. The lower half of the course, with its portion of the tube sheet, was carried about 25 feet directly ahead of its original position. It was this portion which struck and killed the seven men.

The following will outline the conditions existing under the operation of this boiler:

1. The boiler was of great age, and showed much internal and external corrosion.

2. The boiler had been used under excessive pressure.

3. The metal in boiler was of poor quality.

4. The safety valve was too small for safety, being only 1¼ inches in diameter.

5. The plate in the boiler was badly crystalized.

6. The boiler was used at pressures from 90 to 120 pounds.

7. This boiler, if new and in good order, would only be considered safe at 60 pounds.

8. The death of the seven victims makes an eloquent appeal for State boiler inspection.

9. There are more lives lost in Michigan each year than in the whole German Empire due to boiler explosions.

10. The explosions and loss of life is twenty-six times as great in the United States as in Great Britain and Ireland. Should this condition be allowed to continue?

BOILER EXPLOSIONS DURING 1909.*

We present, herewith, our usual annual summary of boiler explosions, giving a tabulated statement of the number of explosions that have occurred within the territory of the United States (and in adjacent parts of Canada and Mexico) during the year 1909, together with the number of persons killed and injured by them. As we have repeatedly explained, it is difficut to make out accurate lists of boiler explosions, because the accounts that we receive are not always satisfactory; but we have taken great pains to make the present summary as nearly correct as possible. It is based upon the brief accounts that we have published in our regular lists in *The Locomotive* during the past year. In making out those lists it is our custom to obtain several different accounts of each explosion, whenever this is practicable, and then to compare these accounts diligently, in order that the general facts may be stated with a considerable degree of accuracy. We have striven to include all the explosions that have occurred during 1909, but it is quite unlikely that we have been entirely successful in this respect, for many accidents have doubtless occurred that have not been noticed in the public press, and many have doubtless escaped the attention of our numerous representatives who furnish the accounts. We are confident, however, that most of the boiler explosions that have attracted any considerable amount of notice are here represented.

The total number of boiler explosions in 1909, according to the best information we have been able to obtain, was 550, which is the greatest number we have ever had occasion to

* From *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company.

report in any one year. There were 470 in 1908, 471 in 1907, 431 in 1906, and 450 in 1905. But while the number of explosions was greater this past year than ever before, we note, with pleasure, that the number of deaths was less than it has been for any year since 1904.

The number of persons killed by boiler explosions in 1909 was 227, against 281 in 1908, 300 in 1907, 235 in 1906, 383 in 1905, and 220 in 1904; and the number of persons injured (but not killed) in 1909 was 422, against 531 in 1908, 420 in 1907, 467 in 1906, 585 in 1905, and 394 in 1904.

The average number of persons killed per explosion during 1909 was 0.413, and the average number of persons injured (but not killed) per explosion was 0.767. The average number of persons that were *either* killed or injured per explosion was therefore 1.180.

The statistics herein given for the year 1909, taken in connection with those given in *The Locomotive* for January, 1909, show that for the period included between Oct. 1, 1867, and Jan. 1, 1910, we recorded 10,601 boiler explosions, these being attended by the deaths of 11,111 persons, and by the more or less serious injury of 16,056 others.

It will be noted that the table gives the number of explosions in April, 1909, as 35, whereas the number actually reported for that month, in our list as printed in the issue for October last, was 36. The change is made because, as noted elsewhere in the present number, we have learned that item No. 161 in the October issue should have been excluded from the list.

During the year 1909 there were many very serious explosions, but we are glad to be able to record that there was none in which the loss of life approached the appalling total that characterized the great explosion at Brockton, Mass., in 1905, or the one on the United States gunboat *Bennington* in the same year. The worst boiler explosion of 1909, so far as loss of life and injury to person is concerned, was the one that occurred in Denver, Col., on June 15. By this explosion six persons were killed, and six others were more or less seriously injured.

SUMMARY OF BOILER EXPLOSIONS FOR 1909.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	61	14	39	53
February	59	11	37	48
March	37	16	24	40
April	35	13	17	30
May	40	21	32	53
June	38	18	32	50
July	40	11	19	30
August	39	25	58	83
September	40	14	42	56
October	60	42	48	90
November	54	19	40	59
December	47	23	34	57
Totals	550	227	422	649

The total loss of property from boiler explosions during the year was very large, although we have no complete figures relating to it. In the Denver explosion, just cited, the immediate damage to property was estimated at $60,000, and the total loss, including damage to wire service and equipment, and through failure to supply power in accordance with contracts, was said to be $200,000. In the explosion at the plant of the Pabst Brewing Company, Milwaukee, Wis., on Oct. 25, the property damage was estimated by the owners to be in excess of $114,000; and we are credibly informed that the explosion at the plant of Radcliffe Bros., of Shelton, Conn., on Dec. 1, damaged property to the amount of $250,000. The total value of the property destroyed by these three explosions alone was thus estimated to be $564,000. Other very disastrous explosions of the year might be included, if our purpose were merely to make as impressive an exhibit as possible. Thus on Dec. 24 a locomotive boiler exploded at Shawnee, Okla., causing a property loss reputed to equal or exceed $100,000; but we have not included this large sum with the three that are mentioned above, because we are not equally well informed as to the accuracy of the estimate.

SUMMARY OF BOILER EXPLOSIONS FROM 1886 TO 1909, INCLUSIVE.

Year.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
1886	185	254	314	568
1887	198	264	388	652
1888	246	331	505	836
1889	180	304	433	737
1890	226	244	351	595
1891	257	263	371	634
1892	269	298	442	740
1893	316	327	385	712
1894	362	331	472	803
1895	355	374	519	893
1896	346	382	529	911
1897	369	398	528	926
1898	383	324	577	901
1899	383	298	456	754
1900	373	268	520	788
1901	423	312	646	958
1902	391	304	529	833
1903	383	293	522	815
1904	391	220	394	614
1905	450	383	585	968
1906	431	235	467	702
1907	471	300	420	720
1908	470	281	531	812
1909	550	227	422	649

FEATURES OF THE MANNING BOILER.*

BY S. F. JETER.

The recent explosion of a Manning boiler, the first and only one which has failed disastrously in the twenty-one years that the type has been in existence, has caused so much discussion of this boiler generally and of special features of its design, that an article upon the subject by one who has for some time been identified with its inspection, design, making and operation, will be timely and perhaps interesting.

Fig. 1 illustrates the general construction of the boiler very clearly, and is a part sectional view; it will be noted that the shell portions of the boiler which are subjected to the greatest stresses are entirely removed from contact with the furnace gases, and these plates can never be subjected to a temperature higher than that of the steam. This type of boiler is practically immune from explosion due to low water, for when the water level reaches a dangerous point, warning is usually given by the collapse of a tube, or if this does not occur, due to a rapid fall of water level, as would result from the opening of a blow-off cock, and the water reaches a point low enough for the crown sheet to be affected, the small amount of water left in the boiler renders serious explosive effect practically impossible. Two such explosions due to lack of water, of which the writer has learned, failed to move the boilers from their foundations; and there have been numerous instances of low water in this type of boiler without serious results.

The firm support of a boiler is one of the necessary features conducive to safe operation, and this is accomplished in the Manning type without relying upon the uncertain support of setting walls or the requirement of expensive structural work; for all that is necessary is a firm foundation upon which the cast iron base may rest. If a brick base is used, as is frequently the case, there is required about 20 inches of brickwork above the floor line; this brickwork is in reality a part of the foundation, and is in no way exposed to the heat from the furnace. The method of support relieves the boiler of practically all strains due to expansion, except such as may be produced by connections to the steam pipiing; this class of strains, however, is common to all types of boilers. The shell sheets of the Manning boiler being away from contact with the fire, permit the use of practically any thickness of shell necessary for high pressures, and this type of boiler can be constructed suitable for 200 pounds or more in capacities up to 500 horsepower. The heat-transmitting surface may be made of prac-

* From *Power and the Engineer*.

tically uniform thicknesses regardless of the size of the boiler. The usual thickness of furnace sheets is 3/8 or 7/16 inch, and the tube sheets are 7/16 to 9/16 inch thick. The most sensitive portion of this boiler is the crown sheet, which receives the direct heat of the furnace and contains as many expanded joints as there are tubes in the boiler; fully 90 percent of the operating troubles that have been experienced with this boiler have been due to leaking tube ends.

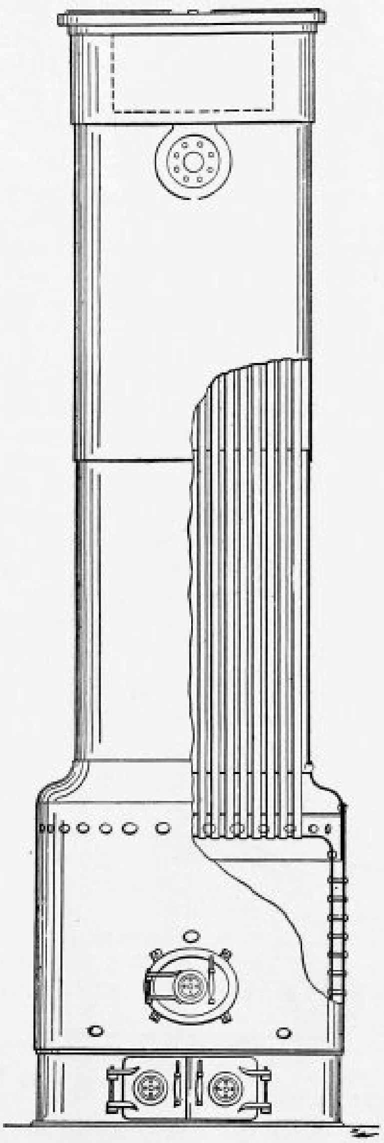


FIG. 1.—PART SECTIONAL VIEW OF MANNING BOILER.

The early designs of the Manning boiler had the ogee flange down near the crown sheet and handholes in the barrel of the boiler, as illustrated in Fig. 2. This did not permit proper access for cleaning the crown sheet, and was soon changed, the handholes being placed on a line with the crown sheet by raising the ogee flange and locating these handholes in the outer sheet of the furnace, as illustrated in Figs. 1 and 5. The Bigelow Company, of New Haven, Conn., who have been among the foremost builders of this type of boilers, early recognized the importance of being able to properly reach all portions of the crown sheet for cleaning and inspection. They devised a system of handholes, properly reinforced, and located around the crown sheet in such a manner that each tube aisle in both directions at right angles to each other could be

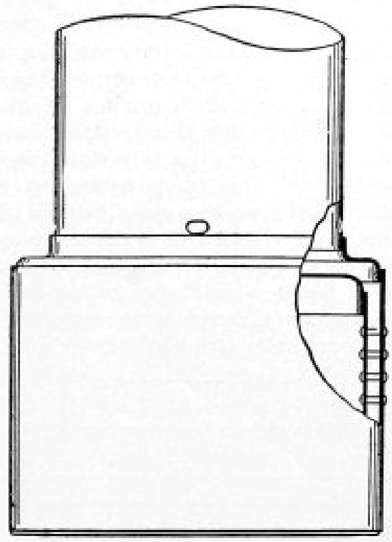


FIG. 2.—ORIGINAL DESIGN OF MANNING BOILER. HANDHOLE IN BARREL.

reached. Fig. 3 illustrates in plan the relative positions of the handholes and tube aisles. Constructed with this cleaning device, the Manning boiler may be operated on any reasonably good feed water with entire success and safety, if proper care is used in removing deposits of scale-forming matter that tend to collect around the lower ends of the tubes and on the crown sheet.

The tube ends, and particularly those at the crown sheet, should be well beaded over on this sheet, as overheating from scale deposits or other causes tends to loosen the tubes in the crown sheet, and proper beading over the ends prevents the pulling out of tubes in this condition until attention is attracted to them by leakage and they can be expanded. The proper beading of the tube ends also preserves the physical characteristics of the metal in the projecting ends of the tubes. A recent accident at Manchester, N. H., which was the first serious explosion of this type of boiler, was probably due, secondarily, to a failure to take the precaution of beading over the tube ends against the crown sheet.

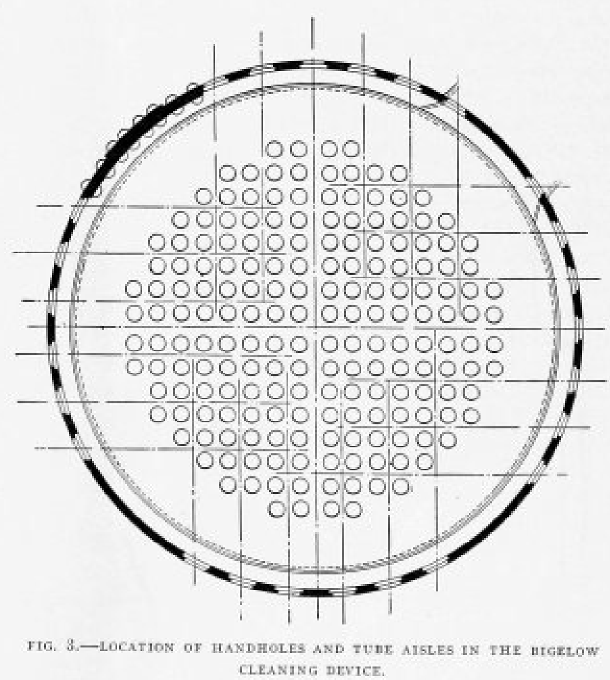


FIG. 3.—LOCATION OF HANDHOLES AND TUBE AISLES IN THE BIGELOW CLEANING DEVICE.

While the design of the barrel above the ogee flange is the same as this boiler as required for any cylinder of similar diameter for withstanding internal pressure, the design of the outer furnace shell is not of the same nature. The only portion of this outer furnace shell which requires its thickness to be based on the diameter is the short section above the stay-bolted surface. The force tending to rupture two cylinders of different diameters which are strongly stayed to each other by pressure applied in the annular space between the two, depends upon the cross-sectional area of the space, and is entirely independent of the diameter. The portion of the construction is illustrated in Fig. 4. The force tending to separate the plates is the area of the sheets in the cross-hatched portion, times the pressure, and is resisted by the four plates, the

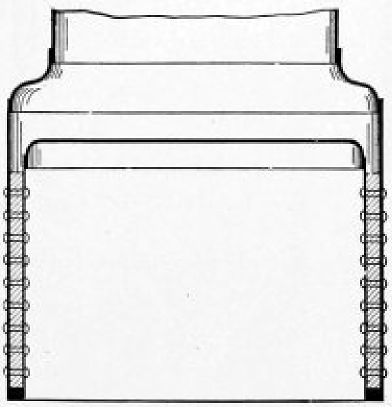


FIG. 4.—AREA AGAINST WHICH PRESSURE ACTS TENDING TO RUPTURE TWO CYLINDERS STAYBOLTED TOGETHER.

inner and outer plates being in tension. On account of the above facts the furnace plates along the stay-bolted surface may be made as thin as will admit of proper staying strength; for the same reasons almost any form of joint that can be made tight is perfectly safe for connecting together the sheets along this section of the boiler. Above the stay-bolted section the diameter becomes a factor in the determination of the strength, and this part should be designed along the same lines as the other cylindrical portions of the boiler.

It has been customary, on account of the requirement for strength of this upper portion of the outer furnace sheet, to make the entire sheet of suitable thickness for its diameter; this construction imposes rather severe conditions on the stay-bolts, for it prevents any flexibility of the sheet (due to its thickness) at the outer ends of the stay-bolts, which greatly adds to their liability to break at the connection to this thick sheet. The writer has modified the design by substituting a

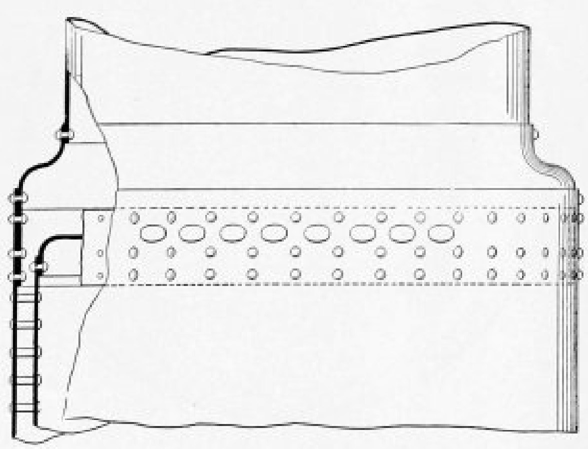


FIG. 5.—THIN OUTER FURNACE SHEET WITH SECTION ABOVE STAY-BOLTS REINFORCED.

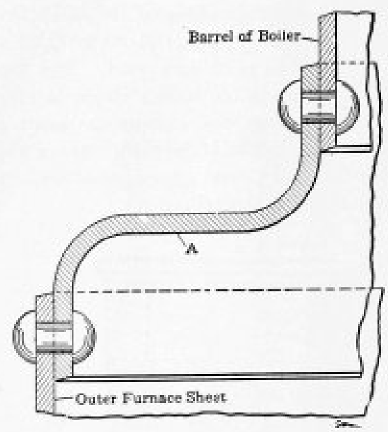


FIG. 6.—ORIGINAL FORM OF OGEE RING.

thin outer furnace sheet and reinforcing the portion above the stay-bolts with a continuous strap, this strap being made integral with the outer furnace sheet by rivets passing through the two plates at frequent intervals. Fig. 5 illustrates this form of construction.

The ogee flange was originally intended to serve as an expansion joint between the upper and lower portions of the boiler, the idea being that the variations in length between the tubes and shell, while the boiler was in operation, rendered such flexibility at this point imperative. The first boilers of this type built had thin ogee sheets with short radius bends and relatively long, flat surface, as illustrated in Fig. 6. This form was, however, later abandoned for the form illustrated in Fig. 7, which was made a true ogee curve with the radii

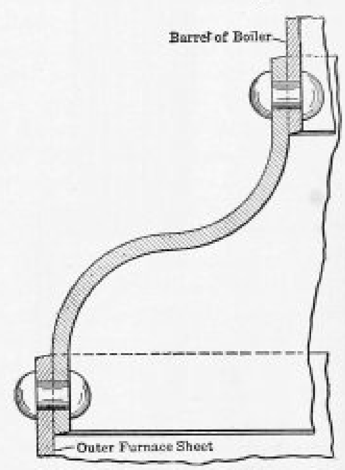


FIG. 7.—IMPROVED DESIGN OF OGEE RING.

meeting at the center and eliminating all flat surface; the sheets were also made very much heavier than in the original design. The reason for this change having been made was on account of the tendency to develop cracks in the ogee sheet about at the point indicated at *A* in Fig. 6. It was assumed by some engineers that these cracks (which were evidently formed by the flexure of the metal) were produced by differential expansion between the shell and tubes, the ogee having been thought necessary to care for this kind of action. Measurements were made while raising steam to demonstrate this to be a fact; however, practically the same variations as were found in such tests were reproduced, by a simple application of hydrostatic pressure, without the slightest temperature changes being involved, and investigation disclosed the fact that the steam pressure on the bottom of the flat surface of the first design of ogee, as illustrated in Fig. 6, together with the thinness of the material, was responsible for the cracking; and it was effectually remedied by the new form and thicker material, as shown in Fig. 7.

Reasoning might have been applied in the first place to indicate the improbability of the differential expansion between the shell and tubes causing any considerable movement in the ogee flange. In the first place it is very doubtful if there exists an appreciable amount of differential expansion between the tubes and shell, except in the act of raising steam, and as will be noted from Fig. 3 (which is drawn to scale for a 130-horsepower boiler) there is considerable flat surface between the flange of the fire sheet and the outer row of tubes, and it is evident that a crown sheet ½ inch thick and with the amount of overhang shown, would not be capable of offering sufficient resistance to the thrust of the tubes to produce any appreciable movement in the plate forming the ogee ring, or, in other words, the flexibility of the outer edge of the crown sheet must have been greater than that of the ogee flange, even with the form first used. This portion of the crown sheet affords ample flexibility, as has been thoroughly demonstrated by the thousands of boilers in successful operation, with practically rigid ogee connecting plates.

The principal advantage derived from the ogee construction, as used in the Manning boiler, is a slightly increased furnace area, without a corresponding increase of diameter or weight of the barrel portion of the boiler; this gain in furnace area is of considerable advantage in the large-size boilers, the ratio between the grate and water-heating surface (using 15 or 16-foot tube lengths), range from 1 to 47 in a 130-horsepower boiler to 1 to 59 in a 300-horsepower size; sizes above 300 horsepower are generally arranged with a brick furnace, and are usually mechanically stoked, this arrangement permitting practically any ratio between grate and heating surface desired, and also admits of increasing the tube lengths to 20 feet.

A tube diameter of 2½ inches has been a standard with the Manning boiler, and no other sizes have ever been tried to the knowledge of the writer.

OPERATIVE FEATURES.

All critics of the Manning type of boiler, as well as other types in which the furnace is surrounded by water-heating surface, lay great stress on the poor facilities offered for the complete combustion of the fuel, and such criticism is undoubtedly well founded. From a limited experience in the analysis of flue gas from this type of boiler, when burning bituminous coal, the writer doubts if it is possible to obtain thoroughly complete combustion with such fuel under regular operating conditions. Practically every other feature leading to economical performance is obtained in the Manning boiler in practically ideal form, and these so completely outweigh the lone defect of slightly impaired combustion that the economical evaporative performance of this boiler is remarkable; it is rarely ever equaled, and doubtless cannot be surpassed by any other type in this respect.

In the first place, the uniform distribution of the furnace gases over the heating surface is practically perfect, regardless of the rate of driving, and the importance of this feature alone as contributing to high efficiency under average working conditions can hardly be overestimated. All the surfaces for the transmission of heat are comparatively thin, which contributes to rapid and economical transfer of heat. All the radiant heat from the fuel bed is absorbed directly by water-heating surface. Owing to the short and direct passage of the gas from the furnace to the flue the friction of the products of combustion through the boiler is greatly reduced, permitting a relatively small tube diameter practical with ordinary draft conditions. The small diameter of tubes used results in high velocity of the gas over the heating surface, and the most recent investigations relative to boiler performance indicate that this rapid flow contributes greatly toward producing a high rate of heat transfer. Owing to the fact that there are no heavy settings to absorb the heat, and that there is comparatively little water contained per square foot of heating surface (about the same as in the average watertube boiler), the Manning boiler responds rapidly to changes in furnace conditions, and for the same reasons the standby losses are comparatively small. In plants operated only ten or twelve hours a day, as is the most usual custom, this feature of low standby losses is of considerable moment.

In addition to the elimination of all expense necessary for setting repairs, the Manning boiler absolutely prevents all losses due to the infiltration of air in the usual form of brick settings, for the only possible way by which air can reach the heating surface is by way of the grate or firing door. It may be judged by the comparatively expensive methods adopted by some of the leading engineers to make boiler setting air-tight, that the question of air infiltration is by no means an unimportant one as regards economy of fuel. The radiation losses in the boiler are reduced to a minimum; using 200-horsepower sizes as a basis for comparison, the average watertube or return-tubular boiler has about 5 square feet of setting surface per horsepower for radiation of heat to the atmosphere, while a similar size Manning boiler has only 2.35 square feet of such surface per horsepower. With proper covering for the Manning boiler the loss per square foot of radiating surface will be less than for the same amount of brick-setting surface, and as this radiation loss is one that continues during the idle time in intermittent operation, it is of great importance to the boiler efficiency under operating conditions, although this is not directly indicated by an evaporative test.

Where the steam generated is to be used for power purposes, one of the strong points of this boiler that produces over-all plant efficiency, is that it furnishes superheated steam. The amount of superheat is slightly variable under different conditions, but it will average about 30 degrees F. when the water level is carried at the customary point (4 feet below the upper tube sheet) and the boiler is operated near its rated capacity. The superheat furnished may be varied by changing the water level, lowering the level increasing the superheating surface and amount of superheat; a 500-horsepower boiler with tubes 20 feet long and with the water level about 7 feet below the upper tube sheet will give approximately 50 degrees superheat when operated at rated capacity. This superheat is obtained without extra first cost, and there is practically no such thing as repairs to the superheating portion of the boiler.

While the Manning boiler is a vertical boiler and requires considerable head room for its installation, it occupies much less ground space than other types of boiler per horsepower, for practically all of the space occupied consists of furnace area, which means that the limit of economy in floor space has been reached in this type of boiler. The floor space occupied by the Manning is about one-half that occupied by the average watertube boiler of the same capacity. To indicate that the features which contribute to evaporative efficiency, as given in this article, actually exist and are by no means imaginary, reference may be made to a series of eleven tests of evaporative performance made on Bigelow-Manning boilers at the plant of the Bristol Manufacturing Corporation, of New Bedford, Mass., in 1894, by Prof. J. E. Denton, of the Stevens Institute of Technology. All of these tests but one were made with bituminous fuel, and the average boiler efficiency obtained was 80 percent., the lowest efficiency being 75.3 percent. The results of this series of tests can probably never be exceeded by any type of boiler built.

Notwithstanding the fact that the Manning boiler excels in safety of operation, economy of floor space, evaporative efficiency, over-all plant economy and also supplies superheated steam, it has another point in its favor that is as fully

(*Concluded on page* 119.)

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Shop Symbols.

In laying out boiler and sheet metal work it is obviously necessary to mark the plates in some manner in order that the workmen who perform the various operations of cutting, punching, bending, flanging, etc., will know exactly what is to be done to the plates without the necessity of consulting the layerout or the foreman. For this purpose certain marks or symbols are used in every boiler shop, and the meaning of these is understood by the men in that particular shop. When, however, a boiler maker goes from one shop to another he is very likely to find that in the new shop entirely different signs are used to indicate the various operations, and before he becomes thoroughly familiar with the new code it is possible that mistakes will be made, which will result in the scrapping of costly material and the loss of valuable time in correcting the error. Such mistakes are, of course, more likely to be made by apprentices than by experienced boiler makers, but while the possibility of such costly errors exists it is obviously worth while to look about for some means to avoid them.

The most obvious method to do this is, of course, to establish a standard set of symbols which shall be universally accepted in every boiler shop. Unfortunately, however, universal standards are difficult to establish, and particularly so in matters of comparatively minor importance like the one under consideration, which affects the management or organization of the shop rather than the commercial product itself. But failing the establishment of a standard practice in this respect there is another simple expedient which will practically ensure immunity from a misunderstanding of shop symbols, and that is to have a certain set of symbols adopted in the shop, and these signs printed and posted in conspicuous places throughout the shop so that the workmen can have no excuse for using the wrong one.

On page 97 is published a set of symbols covering all the important operations performed in a boiler shop, which probably represents fairly universal practice. While we believe that it would be a distinct advantage to have either this or a similar set of symbols recognized as standard throughout the country, yet we do not hope for any such far-reaching result from this suggestion. In view of the benefit to be derived from a clear understanding of shop symbols, however, we would urge foremen and superintendents to consider the advisability of following out the suggestions contained in this article, that whatever symbols are adopted should be printed and posted in a conspicuous place, so that mistakes and misunderstandings will be avoided.

Precautions before Entering Boilers.

Boiler making cannot be classed as a dangerous trade, yet there are times when, unless a boiler maker uses proper precaution, he runs the risk of personal injury, if not of death. Such cases happen most frequently in repair work where a boiler is temporarily cut out from a battery for repairs. Cases have occurred where serious damage has been caused and the workman badly scalded because the manhole of the boiler was opened before the steam pressure had had time to die down or discharge itself through the blow-off. Care should always be exercised before opening boilers, and the workman should satisfy himself that all pressure has been released before any joints are broken. He should not rely upon the reading of the steam gage in this matter, since gages frequently show zero or no pressure even when a few pounds still exist in the boiler. The proper precaution to take is to open either the safety valve or testing tap to the atmosphere. If the boiler is one of a battery the workman should use the greatest care to see that both the steam and blow-off valves are closed before entering the boiler. Isolating valves on both the steam and blow-off connections would ensure immunity from accidents of this kind, but unfortunately these are not always installed. All the manhole and handhole covers should be taken off some time before the workman enters the boiler in order that it may be well ventilated and filled with fresh air. Lastly, the workmen should notify everyone about the premises that someone is working inside the boiler, so that nothing will be done which would endanger his life or limb. The foregoing precautions represent nothing new or extraordinary. On the other hand, they simply emphasize the importance of every boiler maker being thoroughly conversant with the action of steam and with the manner of connecting up and operating a boiler. It may seldom happen that a boiler maker is called upon to have anything to do with the operation of a boiler, but when such is the case it is far better for him to depend upon his own knowledge than to rely upon that of others, the value of which is an uncertain quantity.

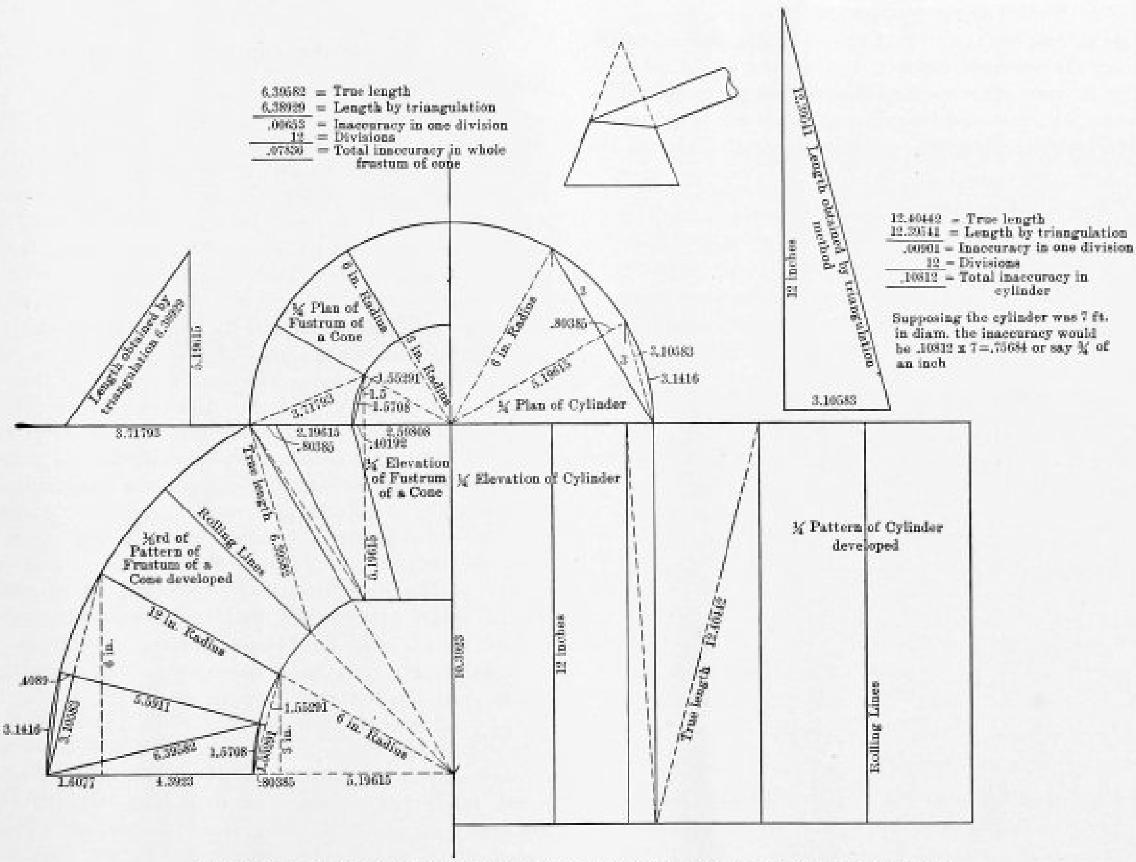
COMMUNICATIONS.

Triangulation.

EDITOR THE BOILER MAKER:

I have read with interest the replies to my letter published in your December, 1909, issue regarding triangulation, and upon further reflection I wish to withdraw my remarks condemning the practice. In fact, I shall adopt the method myself in future, except in cases where the most extreme accuracy is necessary. In making the criticism which I did I was misled by Mr. Linstrom's development of a cylinder cut at an angle, in which what should have been a straight line was shown as an reality curved lines in both the plan and elevation as well as the dotted lines, and the very slight inaccuracy of triangulation would be increased; not only that, it is most essential for the man who is going to roll the plate to know its correct shape.

The method of developing curved surfaces by means of tangents and planes is very useful in giving a correct understanding of irregular pipes, intersecting cones, cylinders, etc., so that the workman can get a correct idea not only of how to develop them but also as a guide in rolling the plates; whereas, if the lines in the plan and elevation are put down indiscriminately the workman is likely to be led astray. In other words, it is not always advisable to divide the top into, say, twelve equal parts and the bottom into twelve equal parts, and con-



SHOWING THE TRUE LENGTH OF LINES AS OBTAINED BY PROJECTION AND BY TRIANGULATION.

irregular curve. After a more thorough investigation of the process I am thoroughly convinced of both its usefulness and accuracy for almost any problem which may come up in a boiler shop.

In the accompanying sketch I have shown the true length of the dotted line, when developed by projection, and also the length as obtained by triangulation. As will be seen, the line is on a cylinder 12 inches diameter and 12 inches high, and twelve lines were used in the development. A similar development is shown with the frustum of a cone.

Now, as regards tangents, planes, etc., which I have suggested as an alternative method for triangulation. A knowledge of this method, as used in the development of curved surfaces, would prove a great help to the layerout along with the knowledge of triangulation, as you can then get the heavy lines in the plan and elevation, which are known to be straight lines, and they then become rolling lines in the development. If this were not done correctly the heavy lines would be in nect these points, and call them generating lines. Of course, this would be correct for a frustum of a cone or cylinder, but it might not be for any irregular shaped pipe.

In reply to J. N. Heltzel's criticism, of course, the generating lines on a cone, or on the frustum of a cone, would all meet at one point, but I will develop the frustum as requested so that he may see the usefulness of the tangent and planes with respect to the rolling or straight lines, and in a future article to THE BOILER MAKER I shall be pleased to show how to develop, by radial lines, a frustum of a cone cut at an angle when the apex of the cone is unattainable.

In respect to the problem shown by Mr. Linstrom, it might be pointed out that a much simpler construction could have been made than was shown; namely, a pipe connecting to a cone, as shown in the small sketch, but as there is only one size cone that would answer this problem I will leave it to the readers to determine the size of the cone, and after they have done so they will see how easy the connection could be made and also how perfect accuracy could then be obtained. The cone shown in the small sketch has purposely been inaccurately drawn. I. J. Haddon.

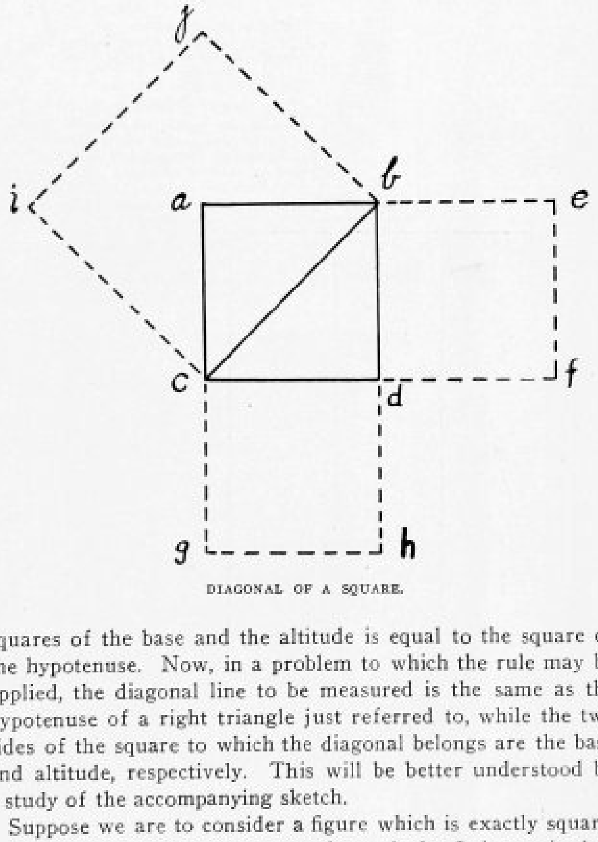
Cardiff, Wales.

Rule for the Diagonal of a Square.

Editor The Boiler Maker:

I note with interest the contents of Mr. G. A. Schust's letter which appears in your March issue, page 86. Many of the readers of your valued paper will no doubt understand just where the constant 1.4142 comes from and why it will serve the useful purpose referred to in the letter in question. There may be some, however, who do not know how the constant was obtained, but would like to learn of it, and for the benefit of these I offer the following explanation:

The rule gives a method of finding the length of the diagonal line joining the opposite corners of a square. The rule will not apply to any other rectangular figure, as cautioned by Mr. Schust. The rule and its constant 1.4142 are based on the basic property of right-angle triangles; that the sum of the



Diagonal of a Square.

squares of the base and the altitude is equal to the square of the hypotenuse. Now, in a problem to which the rule may be applied, the diagonal line to be measured is the same as the hypotenuse of a right triangle just referred to, while the two sides of the square to which the diagonal belongs are the base and altitude, respectively. This will be better understood by a study of the accompanying sketch.

Suppose we are to consider a figure which is exactly square, each side of the same to measure just 1 inch. It is required to find the length of the diagonal. Let *a b c d* be 1 inch square. According to the rule which we have in hand, the diagonal *b c* is $1.4142 \times 1 = 1.4142$ inches. If the figure be correctly drawn and a scale be laid on *b c*, it will measure 1.4142 inches.

If a square be constructed on the side *b d*, as shown by the dotted lines *b e f d*, and another square be made on the side *c d*, as shown by the dotted lines *d h g c*, the sum of the two squares so formed will equal in area the large dotted line square constructed on the diagonal line *b c*; *c d* is the base of the triangle, *b c d*, and *b d* is the altitude, while *b c* is the hypotenuse.

According to the basic principle before referred to, if each of the smaller dotted squares is 1 inch square (and therefore 1 square inch), and the sum of these squares is equal to large dotted square *b c i j*, then this latter must be 2 square inches. Having the area, the side *b c* may be found by extracting the square root of the number 2, which is 1.4142 inches. A close inspection of the whole figure should show why the square *b c i j* contains the same area of the two squares *b d f e* and *c d h g*. The triangle *a b c* is half of the square *a b c d*, and it is easy to see that triangle *a b c* is just one-quarter of the square *b c i j*. A person need not have an extensive knowledge of either geometry or trigonometry to reason out the foregoing, in order to learn how the value 1.4142 is obtained, and why it may be used in any case other than that chosen in the illustration. The relationship is the same no matter what the measurements may be as long as it is used only to find the length of the diagonal of a square.

Scranton, Pa. Charles J. Mason.

Rule for the Diagonal of a Square.

Editor The Boiler Maker:

I wish to thank Mr. G. E. Schust for bringing to my attention the mistake in the constant .70781 used in finding the diagonal of a square by the method which I outlined in your January, 1910, issue. This mistake is very misleading, and the constant should have been .70711 instead of .70781, but if Mr. Schust will refer to the table in the January issue opposite the number 4 he will see that the constant is .70711 for an inscribed square.

Further, Mr. Schust says I did not state that this rule was only applicable when the legs of the triangle were equal. If he will kindly read my article again he will find that I stated "Let it be required to find the diagonal of a square." This, of course, is equivalent to saying that the legs must be equal, since the sides of a square are always equal.

Mr. Schust offers what he considers a simpler and more reliable rule. This, however, is not so; for example, if we take the same problem as stated in the March issue and assume the lengths of the legs to be 18 inches, then, according to Mr. Schust's rule, the diagonal would be 25.4556 inches. By the square root method the diagonal equals 25.4558 inches, making the error in Mr. Schust's method 2/10,000 inch. Now by applying my rule, using the constant .70711 multiplied by the sum of the legs, we have as the length of the diagonal 25.45596 inches, which is practically the same result as that obtained by Mr. Schust, or if anything a little more accurate. In view of this it is hard to see where Mr. Schust's rule is any more simple and reliable than mine. In fact, the two rules are practically the same thing, since the constant 1.4142 is two times .70711, and multiplying one leg by the constant 1.4142 gives the same result as multiplying the sum of both legs by the constant .70711.

Boston, Mass. Frank T. Saxe.

PERSONAL.

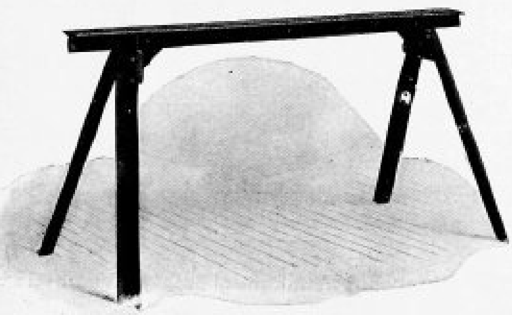
James Kelly has been appointed general foreman boiler maker of the Chicago & Northwestern Railway. William Bower has succeeded Mr. Kelly as foreman of the Chicago shops.

William H. Fischer, formerly superintendent of manufacture for the Bird-Archer Company, and Thomas S. Service, T. W. Oakes and William Morley, formerly salesmen for the same concern, have all recently gone into the employ of Green-Hook & Company, Inc., of Baltimore and New York. In anticipation of increasing demand for their Mercurifilm Boiler Water Treatment, Green-Hook & Company are increasing their sales organization rapidly, and are engaging capable representatives in many cities in this country and abroad.

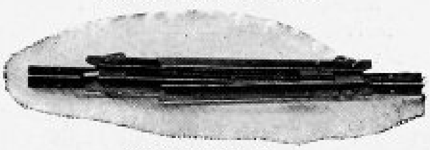
ENGINEERING SPECIALTIES.

A Collapsible Steel Horse or Trestle.

A collapsible steel horse or trestle has recently been patented and is now being manufactured by S. M. Hildreth & Company, 2 Rector street, New York City. As can be seen from the illustration, it is a strong, simple, convenient and practical appliance for innumerable users, such as builders, carpenters, contractors, machine shops, painters, piano movers, pipe works, manufacturing plants, stores and shops of all kinds, and for various other purposes too numerous to mention.



STEEL COLLAPSIBLE HORSE.

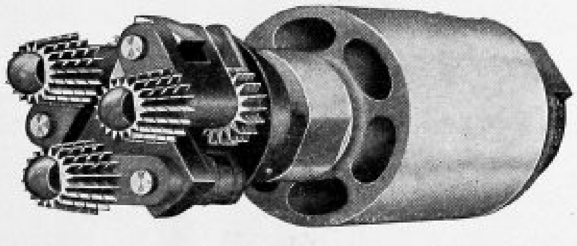


HORSE FOLDED UP.

The horse is made of nickel iron and is, therefore, very rigid and strong, precluding any chance of breakage. It is made in several heights and lengths, suitable for various purposes. The legs fold up when the trestle is not in use, so it can be stored away in a very small space and conveniently handled in transporting. It is claimed that they will withstand more weight than any other horse or trestle of the same size.

New Form of Head for Boiler Tube Cleaners.

The Lagonda Manufacturing Company, of Springfield, Ohio, has recently brought out a new boiler tube cleaner equipped with what is known as the "quick repair head." This head is attached to the turbine proper by means of the coupling and an adapter. As can be seen from the illustration, which shows a "quick repair head" attached to a Weinland water turbine, a spider screws directly into the coupling, and



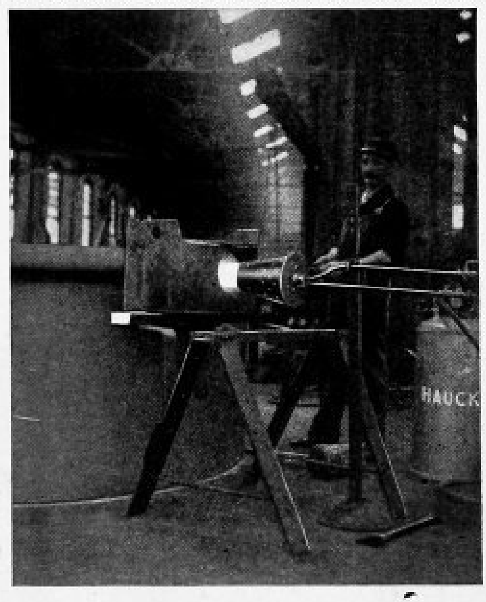
has three arms, on the end of which are attached the swinging arms carrying the cutter wheels. There are four cutters on each swinging arm; the front one being of the cone pattern, is the first to attack the scale and loosen it. Each cone cutter is then followed by three star cutters, which remove the scale down to the metal, leaving a bright, polished surface.

The most important feature of this head is the ease with which new cutters can be inserted. The cutter pin can quickly be removed by means of a wrench and all of the cutter wheels taken out. In case the entire head must be taken apart it is only necessary to unscrew the spider from the coupling; this allows the three arm pins to drop out and the whole head is dismantled. There are no rivets or small parts used, and as the makers furnish an extra supply of sharp cutter wheels with each head there is no reason why any operating engineer should struggle along with a scale remover having dull cutter wheels.

The quick repair head is compact and heavily built. The arms are thrown out against the scale by the action of centrifugal force. This causes the cutter wheels to bear firmly against the scale, but should a constricted part of the tube be met the arms fold in and, it is claimed, do not injure the boiler tube. The flywheel effect of a compact head like this is quite noticeable. When exceptionally hard scale is encountered it is only necessary to back the cleaner out a little and let the head speed up, and when it is again forced against the scale it is generally found that the cleaner will eat its way through without any further trouble.

Hauck Patent Oil Fuel Burners.

The illustration shows an application of the Hauck portable oil-fuel burner which is useful in the boiler shop. A shell 11 feet in diameter by 5/8 inch thick is being offset for a space 14 inches by 5 inches. This entire work was completed by three men in nine hours. The heat, which was obtained from a Hauck burner, was confined in a separately constructed box of sheet iron lined with firebrick, and by means of this arrangement it is claimed that the flanging heat was obtained over a

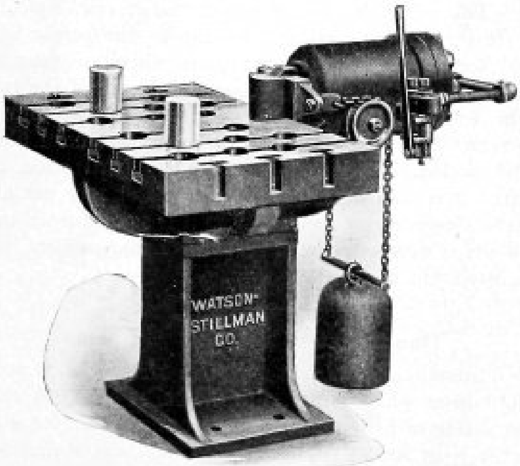


space 30 inches long by 14 inches wide in three minutes. These burners are manufactured by the Hauck Manufacturing Company, Brooklyn, N. Y., and have been largely used in various boiler shops for heating distorted plates, for annealing, flanging, scarfing, shrinking and similar work. It is claimed that their use results in an enormous saving in time and labor. The torch shown in the illustration is operated by compressed air under pressures varying from 5 to 100 pounds per square inch. Any grade of fuel, crude or kerosene, oil may be used.

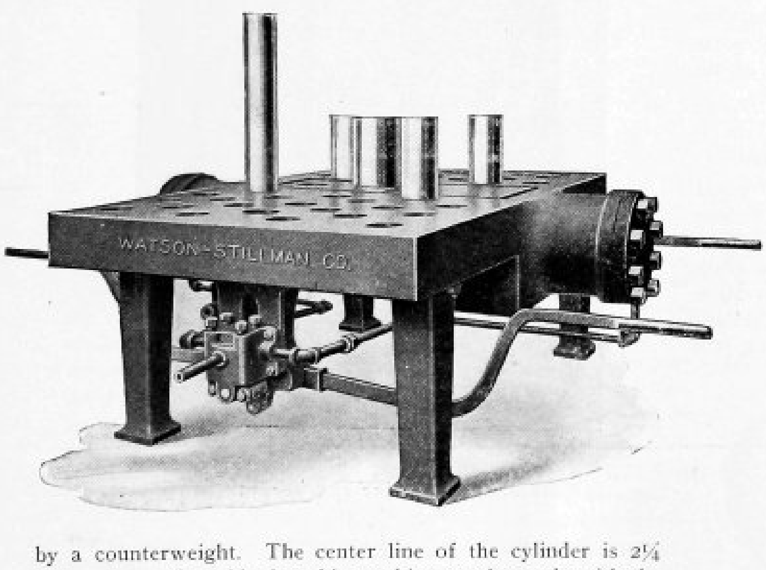
Two New Powerful Hydraulic Bending Machines.

The Watson-Stillman Company, of New York, has just introduced two new bending machines which should prove of interest to all who have large pipe, structural sections, metal bars and similar sections to bend. The frames and cylinders of these machines are cast iron and the cylinders are copper lined. The rams and bending pins are machinery steel. A positive stop is provided in both instances to prevent the ram from passing out beyond a safe limit.

The smaller machine shown is capable of exerting a power of 25 tons under a hydraulic operating pressure of 2200 pounds per square inch. The table is 2 feet long by 3 feet 4



inches wide and is provided with 18 round holes staggered in rows which are symmetrically placed with respect to the ram. Round pins, each 3½ inches in diameter, can be placed in any of the holes and the work may further be held in place by bolts set in any of the key slots on the top and sides of the table. Modifications of this table top are made where necessary to conform to some special use. The ram has a travel of 8 inches and is brought back to the beginning of the stroke



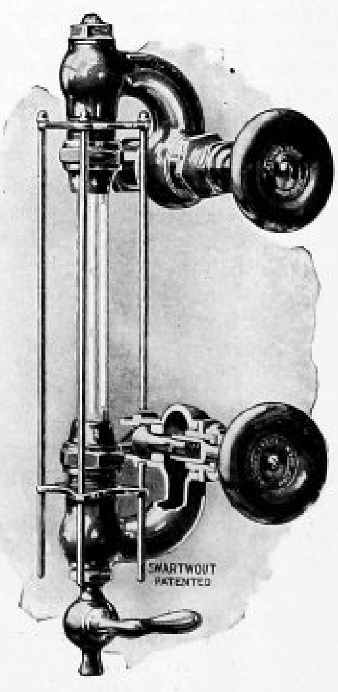
by a counterweight. The center line of the cylinder is 2¼ inches above the table, but this machine can be made with the bending block higher above the table or, by making the ram travel in guides, the center line may be below the table. The cylinder head is removable and provided with air passages for removing entrained air or draining if desired in cold weather. The operation of the ram is controlled by a stop and release valve at the side of the cylinder.

The second bender is considerably larger and capable of exerting 30 tons pressure. In this instance the table is 4 feet wide by 6 feet long and has two opposed 7-inch cylinders of 12-inch stroke arranged to operate in either direction, the double-headed ram extending between them. The table as shown has 21 holes on each side of the ram and staggered in six rows. The movable pins are interchangeable and 4½ inches in diameter. The larger or bending pin shown in the center is attached to a saddle on the ram. The ram works in machined guides and is covered to prevent scale or dirt from reaching the contact surfaces. These surfaces are further protected from dirt by plugging the oil holes in the cover with screw plugs. As in the smaller press the cylinder heads are removable and provided with air passages which also permit drainage. The valves are placed in one body and may be operated by any of the four levers at the corners of the press. The arrangement is automatic, so that opening of pressure or release valves for one cylinder opens the opposite valve of the other cylinder, the movement being stopped by removing the hand from the lever. A pair of bending blocks faced with a hard steel may be substituted for the bending pin. The cylinders are cast higher up for uses where it is desirable to obtain greater power. In this instance the rams are usually made independent and single-acting and are returned by counterweights similar to that shown on the small machine.

The Swartwout Automatic Safety Water Gage.

The Swartwout automatic safety water gage, manufactured by the Ohio Blower Company, Cleveland, Ohio, eliminates so far as is possible the dangers resulting from broken gage glasses and the subsequent damage to both attendant and boiler. In each of the two gage bodies there is an automatic valve held away from its seat while in use by a spring. In case of breakage this valve is closed quickly by the steam pressure in the boiler. The valve is also controlled by the hand wheel, so that both valve and valve seat are easily removed for cleaning without disturbing the gage at the boiler connections and without removing the packing of the gage glass.

The parts of the valve are held together by a single screw,



so they can be readily removed. At the inner end of the valve stem, a flat scraper loosens any sediment adhering to the boiler connection, and as it revolves with every turn of the hand wheel the opening is cleared frequently. The valve case is removable and is provided with two external threads of the same pitch, but of different diameters, so that the threads on the inner end may slip by the outer internal thread when inserted. The threads are cut so that both sets engage the threads of the gage body at the same time, thereby insuring a good fit.

On replacing a broken glass the hand wheel is turned forward until the valve is forced from its seat, thus allowing water or steam to flow from the boiler into the gage glass; the valve on the other gage body will then automatically open to equalize the pressure. In turning the hand wheel forward to force the valve from its seat, the movement of the spring in the stem must first be taken up before the valve moves. Every turn of the wheel turns the valves upon their seats. In this way they regrind themselves automatically. When the valve case is removed there is an unobstructed opening into the boiler 1 inch in diameter, obtained without in any way disturbing the gage bodies.

Another ingenious feature of the Swartwout gage glass is the gooseneck gage body. This form of construction allows a gage glass 2 to 4 inches longer than with other makes, thus giving greater visible range of water level. Offsetting the gage glass renders the operation of replacing a broken gage glass an easy task. It is inserted through either the top or bottom of the gage without in any way disturbing the valves or seats. It need not be of any particular length, an inch or more making no difference. It permits the use of softer packings, which, with the flexible construction, relieves the strain on the gage glass, thereby greatly reducing breakages. In cleaning also the value of the gooseneck is apparent, for by simply removing the top plug or the drain cock at the bottom, the swab for cleaning is easily inserted, without in any way disturbing the valves or gage bodies.

The Swartwout water gage and gage cock are made extra heavy to withstand a pressure of 250 pounds. They are adapted to all types of boilers and for marine, locomotive, stationary and portable service. They are always provided with four rods and glass 24 inches long.

Features of the Manning Boiler.

(Concluded from page 113.)

appreciated by the commercial man as by the trained engineer, and this is low first cost. Comparing the price of the watertube, return-tubular and Manning type of boilers on a basis of 200-horsepower sizes, the price per horsepower, set and covered, ready for steam and smoke-flue connections, and with the watertube and return-tubular boilers supplied with superheaters capable of delivering the same quality of steam as furnished by the Manning boiler, the prices per horsepower would range about as follows:

Watertube	$16.75
Return-tubular	12.15
Manning	9.50

Omitting the superheaters on the first two the prices would be:

Watertube	$15.00
Return-tubular	10.40
Manning	9.50

Doubtless many engineers who have had unsatisfactory experience with the vertical tubular type of boiler, owing to their inability to reach and clean the crown sheet, have become strongly prejudiced against this type; to such the writer would say, that the Manning boiler if equipped with the Bigelow cleaning device is as different from the usual construction in regard to accessibility as the open and closed type of feedwater heater.

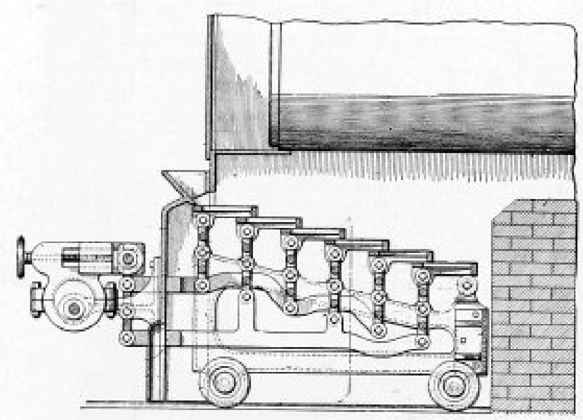
SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

945,469. AUTOMATIC MECHANICAL STOKER. LEWIS A. MAPEL, OF ST. LOUIS, MO., ASSIGNOR OF ONE-SIXTH TO WM. J. TUCHER, ONE-SIXTH TO PERRY W. FALLIS, ONE-SIXTH TO PATRICK M. QUIRKE, ONE-SIXTH TO W. CLARENCE WOOD, AND ONE-SIXTH TO CHAS. H. JONES, ALL OF ST. LOUIS, MO.

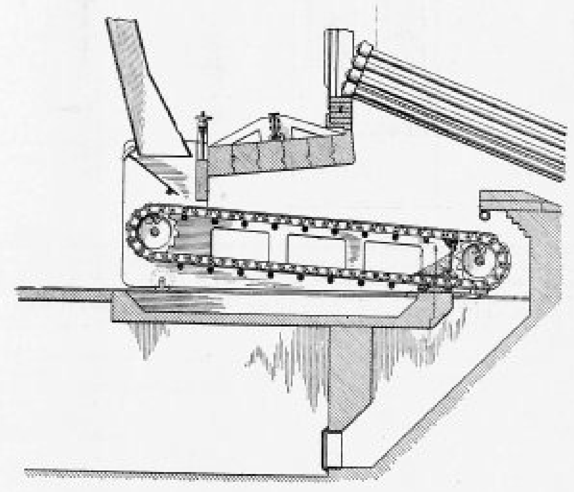
Claim 1.—The combination of a plurality of transversely arranged overlapping grate bars, a plurality of vertically disposed movable supports therefor, each of said supports being fulcrumed beneath said grate bars,



the rear side of each grate bar being pivotally connected to the upper part of its respective support and the front side thereof resting on the next succeeding grate bar, and means for simultaneously rocking said supports. Two claims.

946,762. CHAIN-GRATE FURNACE. LEROY H. MAXFIELD, OF GODFREY, ILL., ASSIGNOR TO ILLINOIS STOKER COMPANY, OF ALTON, ILL., A CORPORATION OF ILLINOIS.

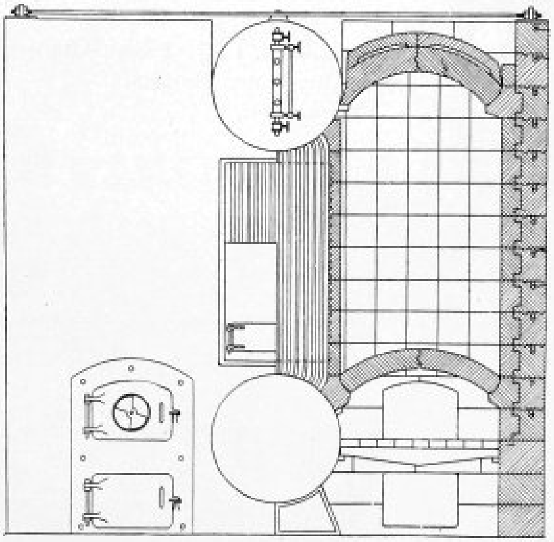
Claim 2.—In a furnace, the combination of a chain grate wherein articulately connected links travel around supports at the front and rear, rollers beneath the lower grate run for supporting it, one of said rollers



being located ahead of the other, and a wall located beneath said rolers and extending from one to another thereof, whereby the rollers retain ashes upon the wall for sealing the space between the top of the wall and the lower grate run. Two claims.

946,840. STEAM-BOILER FURNACE. ELLIS F. EDGAR, OF WOODBRIDGE, N. J.

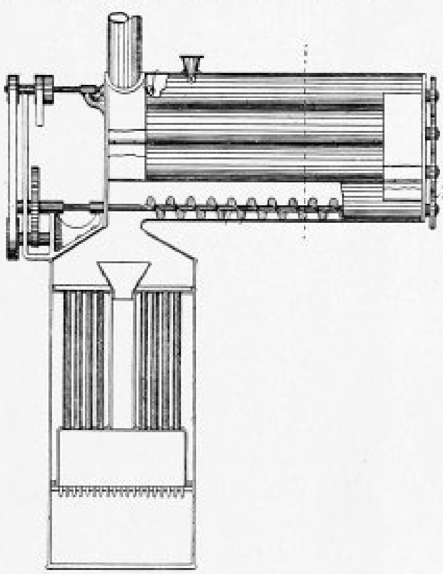
Claim 1.—The combination of a water-tube boiler composed of upper and lower drums connected by water tubes and a furnace having an outer casing, said furnace comprising a grate or floor, a non-combustible arch in said furnace, located a short distance above said grate or floor and extending almost the length of said furnace, leaving a space between the end of said arch and outside casing, and a baffle wall extending from the lower drum to the upper drum and extending from the



outside casing beyond the end of said arch as much as the space between the end of said arch and outside casing. Two claims.

946,788. APPARATUS FOR TREATING AND UTILIZING PEAT FUEL. WILBUR L. SHEPARD, OF ELMWOOD, AND HORACE J. WICKHAM, OF MANCHESTER, CONN.

Claim 1.—The combination with a vertical boiler and furnace having a fire box below and a smoke box above the boiler, of tubes communicating with each other alternately at opposite ends, conveyers in said



tubes, means for driving the conveyers, a connection between the bottom tube and the smoke box above the boiler, a fuel passage from the smoke box above to the fire box below the boiler, a smokestack opening from the top tube, and means for admitting peat to the top tube. Five claims.

947,689. LOCOMOTIVE EXHAUST. MATHIAS SPEICHER, OF CARBONDALE, PA., ASSIGNOR OF ONE-HALF TO DAVID M. GRIFFITHS, OF CARBONDALE, PA.

Claim.—A smoke and steam exhaust nozzle for locomotives, having a supplemental nozzle, a bypass leading from said exhaust nozzle to said supplemental nozzle, the intake end of said bypass being spaced from said supplemental nozzle, a valve in said bypass arranged to open toward the supplemental nozzle, and yielding means to normally close said valve and permit the opening thereof by abnormal increase of steam pressure in the exhaust nozzle. One claim.

948,021. LOCOMOTIVE EXHAUST-PIPE. JOHN PLAYER, OF SCHENECTADY, N. Y.

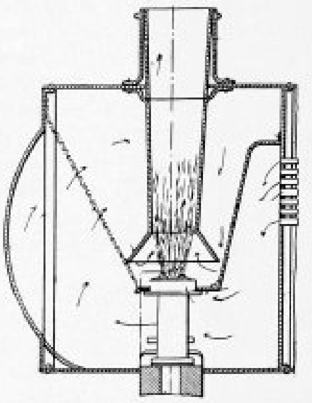
Claim 1.—The combination, in a locomotive engine, of a bed plate having exhaust passages terminating in a seat for the exhaust pipe, an exhaust pipe adapted thereto, and a metallic grinding block interposed between said seat and exhaust pipe. Three claims.

948,020. EXHAUST-PIPE. JOHN PLAYER, OF SCHENECTADY, N. Y.

Claim 1.—A locomotive exhaust pipe having an annular passage for the discharge of the blast jet, a central passage for the discharge of the entrained gases, and a plurality of lateral passages, for the entrainment of gases, leading from its exterior into, and disposed relatively to, said central discharge passage, so as to induce, by the action of the blast jet, rotation or gyration of the column of gases discharged from said central passage. Fourteen claims.

947,660. DRAFT APPLIANCE FOR STEAM-ENGINE BOILERS. JAMES S. DOWNING, OF ATLANTA, GA., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO DOWNING LOCOMOTIVE DRAFT APPLIANCE COMPANY, OF ATLANTA, GA., A CORPORATION OF GEORGIA.

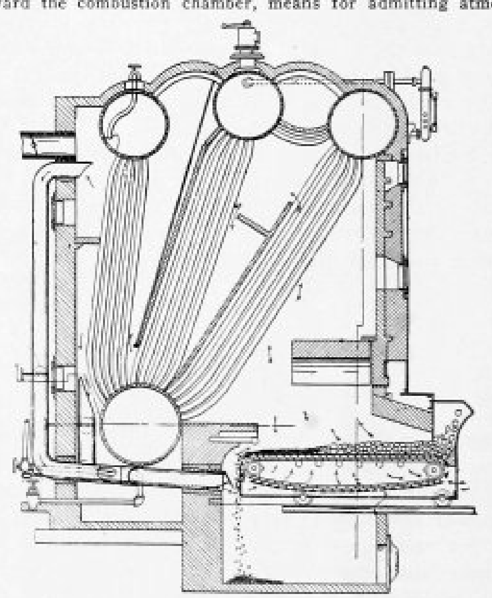
Claim 1.—The combination with a stack, of a tapered lift pipe disposed as a continuation thereof and formed with a petticoat at its



lower end, and a plurality of exhaust nozzles side by side and so formed that their axes converge upwardly and discharge into and substantially fill the lower end of the lift pipe. Five claims.

947,804. MEANS FOR CONTROLLING DRAFT-AIR TO BOILER FURNACES. LUCAS DUFFNER, OF ST. LOUIS, MO.

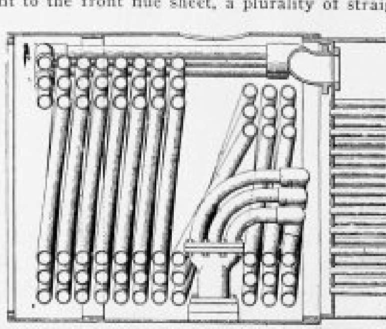
Claim 1.—In combination with a boiler furnace provided with a firebox and a combustion chamber, a grate for supporting and advancing the fuel toward the combustion chamber, means for admitting atmospheric



air beneath the front of the grate, a flue leading from the combustion chamber for returning and discharging a portion of the hot combustion products along the bottom of the rear of the grate and in a direction opposed to the general direction of flow of the atmospheric air, and a jet nozzle for projecting the returned combustion products under the section of the grate occupied by the ashes. Two claims.

948,331. SUPERHEATER. HENRY W. JACOBS, OF TOPEKA, KANSAS.

Claim 1.—A locomotive smoke box superheater comprising an inlet header adjacent to the front flue sheet, a plurality of straight tubes lead-



ing forward therefrom to the front end of the smoke box, a plurality of helical tubes having a common axis leading thence back to a point adjacent the flue sheet, and connections therefrom to the locomotive steam chests. Eight claims.

THE BOILER MAKER

MAY, 1910

A METHOD OF HANDLING FLUE WORK.

BY C. E. LESTER.

The really proper manner of doing flue work, as well as the proper tools for doing the work, has been a bone of contention among boiler makers since the very inception of steam boilers. It is, of course, a well-known fact that, as far as improvements in tools for flue setting are concerned, there are none to speak of later than the sectional expander of the prosser type. We have roller expanders and prosser expanders of a great many varieties, each with claims of superiority over the others; but practically the same tools as those in use twenty-five years ago, *i. e.*, prosser and roller expanders.

Considering the foregoing conclusions to be facts it becomes necessary for those interested to get the best possible results from the tools and methods available.

Until very recently it has been customary on most railroads, and I suppose on some this very day, for the foreman boiler makers of the several shops on the railroad system to handle

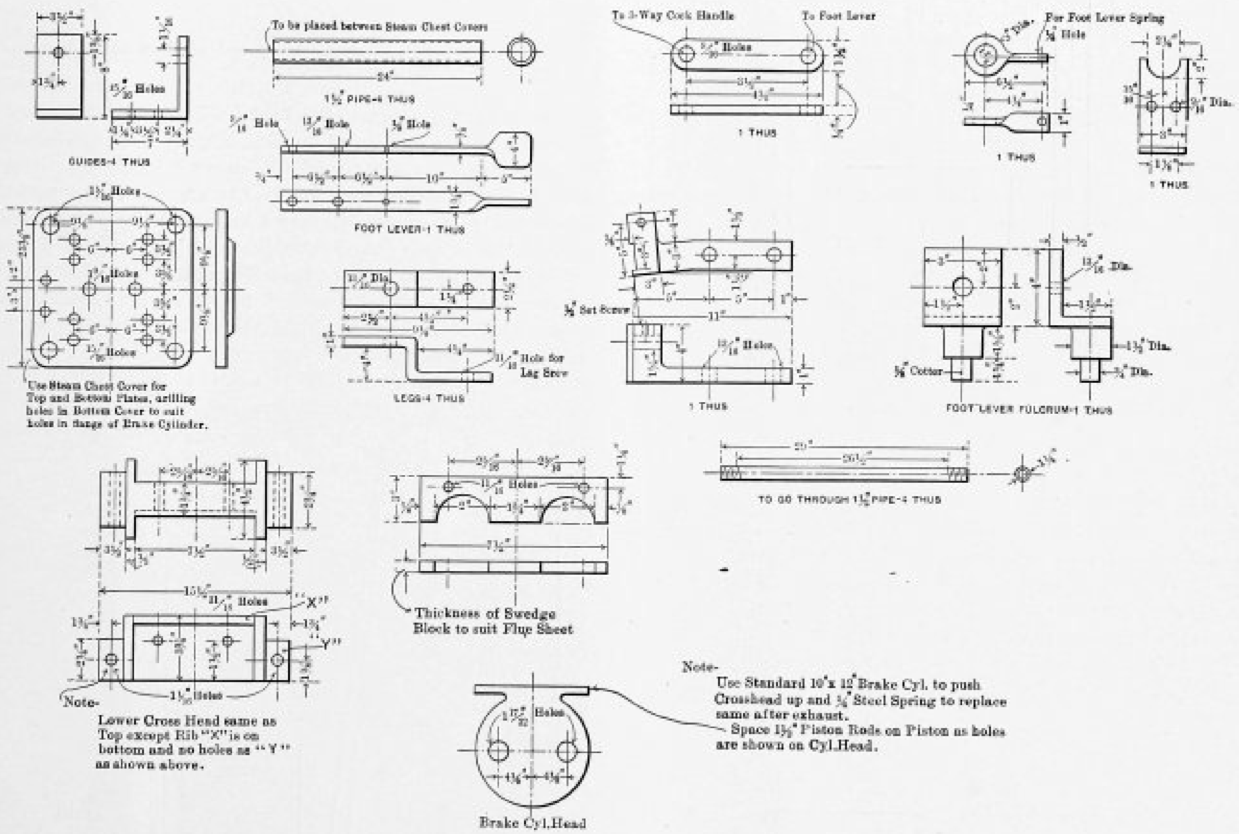


FIG. 1.—SWEDGING MACHINE DETAILS.

flue work, as well as everything else, as they choose. If they desired 3/16 inch or 5/16 inch for a bead, a heavy or a light ferrule, flues rolled by hand or by motor, beading tools made in any and all sizes, it has been the foreman's privilege to have the work done as he desired. The unquestionable folly of such lax methods is particularly discernible when power is transferred from one division to another. The ideas of the foremen at the different shops are seldom alike, and the consequence is that the difference in tools and manner of doing

having used nearly, if not all kinds, I find (this is, of course, my individual opinion) very little difference in any of them, only that the later patterns of self-feeding roller expanders for use with an air motor and the prosser expanders of the several types to be used in connection with an air hammer, are more rapid and, consequently, quite necessary for the boiler maker to keep up with the procession; but as far as any difference in the quality of work is concerned, there is but little difference, and we are to-day doing our flue setting with

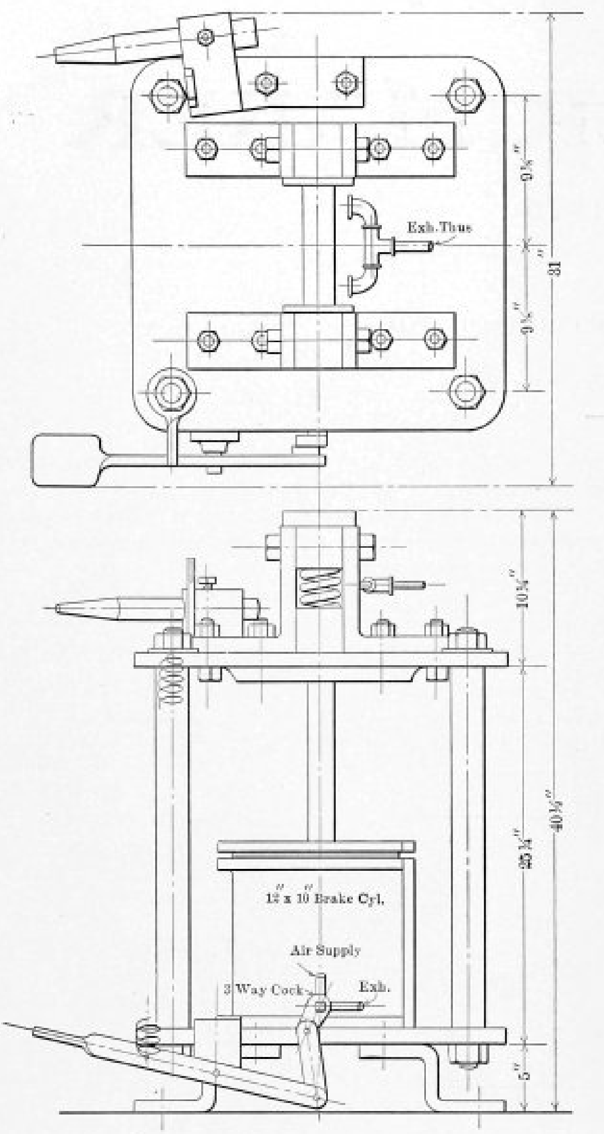


FIG. 2.—GENERAL DESIGN OF SWEDGING MACHINE.

work soon puts the flues out of commission. The majority of the railroad systems of any magnitude have become cognizant of the bad features connected with such haphazard methods, and have undertaken to lessen cost of maintenance and lengthen the life of flues by standardizing tools, materials and methods of performing the work.

To obviate flue failures to the greatest degree possible, and to increase the life of flues, the company with which I am con-

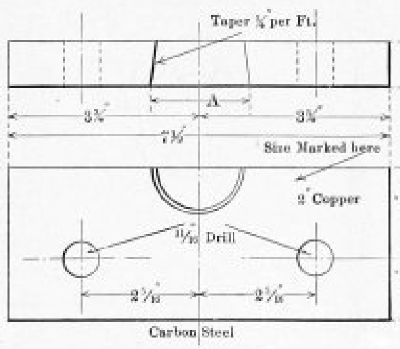
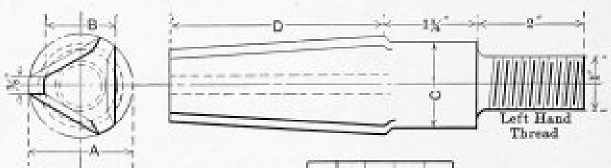


FIG. 3.—BOILER FLUE SWEDGE BLOCK. (SEE TABLE I.)

TABLE I.—SIZES OF SWEDGE BLOCK IN INCHES.

Flue.	Copper Ferrule.	A.
1½	1½	1⅜
1½	1 9/16	1 7/16
2	2	1⅞
2	2 1/32	1 29/32
2	2 1/16	1 15/16
2	2⅛	2
2¼	2¼	2⅛
2¼	2 5/16	2 3/16
2½	2½	2⅜
2½	2 9/16	2 7/16
3	3	2⅞

nected has adopted an elaborate set of tools and gages and a standard method of setting flues. The method of setting flues may be criticised, and I have no doubt but that it will be, so I desire to state that the method was decided upon by a com-



No.	A	B	C	D
1	1 13/16	1¾"	1⅝"	4"
2	1⅞	"	"	"
3	1 15/16	1½"	1⅝"	"
4	2"	"	"	"
5	2 1/16	1⅜"	1¾"	4½"

FIG. 4.—MANDREL FLUE SPREADER.

Note.—Mandrel for spreading front end of flues to be attached to pinion of shaft of Hartz flue welder.

mittee from the several divisions having under their supervision the boiler work, and considering the varying conditions of every description the method set forth below was decided upon as the best for this particular territory. I may add that in our several opinions, whether a flue should be prossered and then rolled or rolled and then prossered, or any of a dozen different ways of mixing the several operations, makes but little difference in the final result, if the work is conscientiously done. The method adopted is as follows:

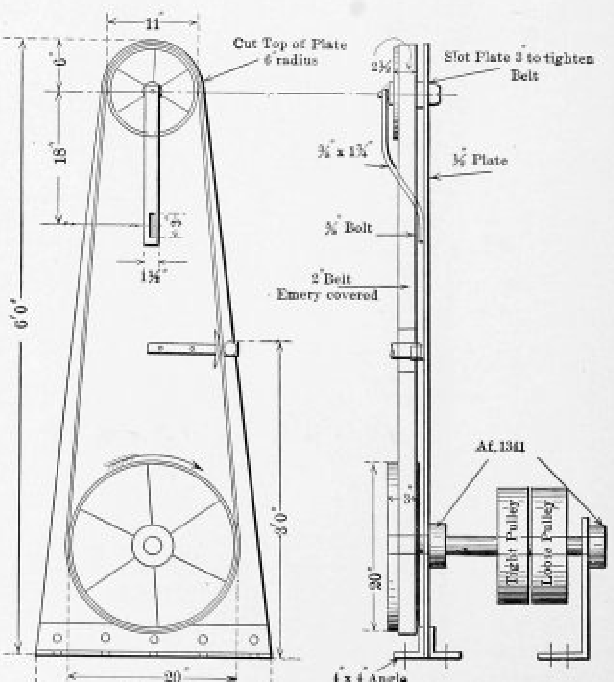


FIG. 5.—FLUE GRINDING MACHINE.

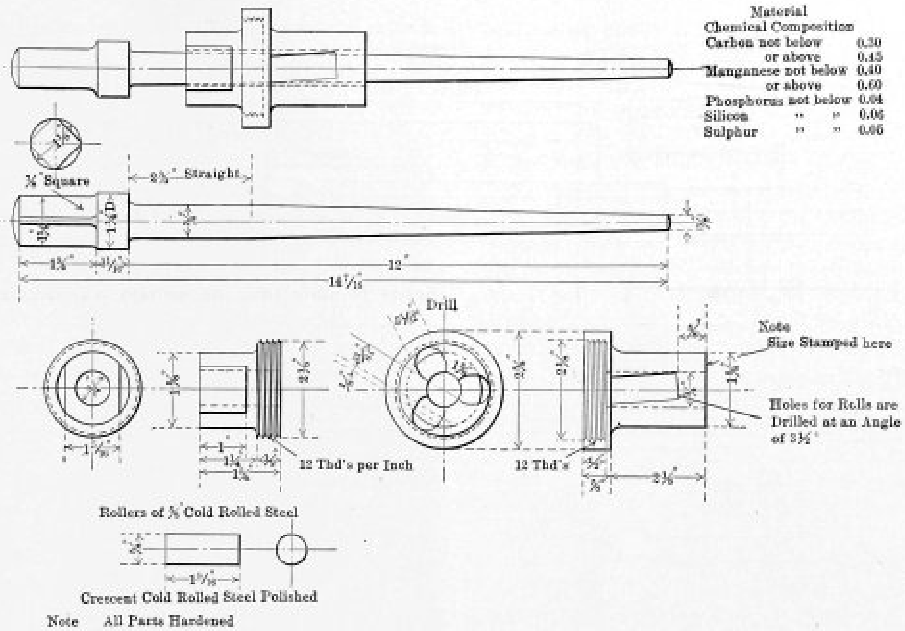


FIG. 6.—1⅝-INCH FLUE EXPANDER.

Flues are in most cases removed by cutting off the beads in the fire-box with an air hammer, and cutting off in the front end with a rotary cutter that cuts the flue off in one revolution of the cutter (this is a patented cutter and is on the market). After the flues are cleaned, cut off, and the safe ends welded on (we have in use both the roller and pneumatic types of welding machines), they are swedged in a pneumatic swedging machine of the company's design (see Figs. 1 and 2), with swedge blocks tapered ¾ inch to the foot to give a light driving fit (swedge blocks shown in Fig. 3 to suit all sizes of flue holes). The flues are then cut to finished length, heated and opened up to fit the front sheet with the mandrel shown in Fig. 4, which is attached to a Hartz welding machine, and the scale is ground off with an emery belt shown on the flue grinding device, Fig. 5. The flues are then delivered to boiler and handled in the following manner:

FLUE SETTING.

Fire-Box End—(1) All burrs and scale must be removed from the flue holes, back and front sheet, and if the holes are more than 1/32 inch out of round they must be reamed true.

(2) Copper ferrule .075 mm. gage and ⅛ inch wider than the thickness of the sheet, to be fastened in the back flue sheet with sectional expanders, ferrule to be flush with the sheet on the fireside.

(3) Flue to be swedged to proper size, applied and driven through the sheet 3/16 inch and rolled tight with standard roller expanders shown in Fig. 6 (this for 2-inch flues; other sizes shown on other prints).

(4) Flue to be belled with standard spreading tool, Fig. 10; sizes shown are for 2-inch, 2 1/16-inch and 2⅛-inch holes, then prosser expanded with standard prosser expander, Fig. 7, for 2-inch flues.

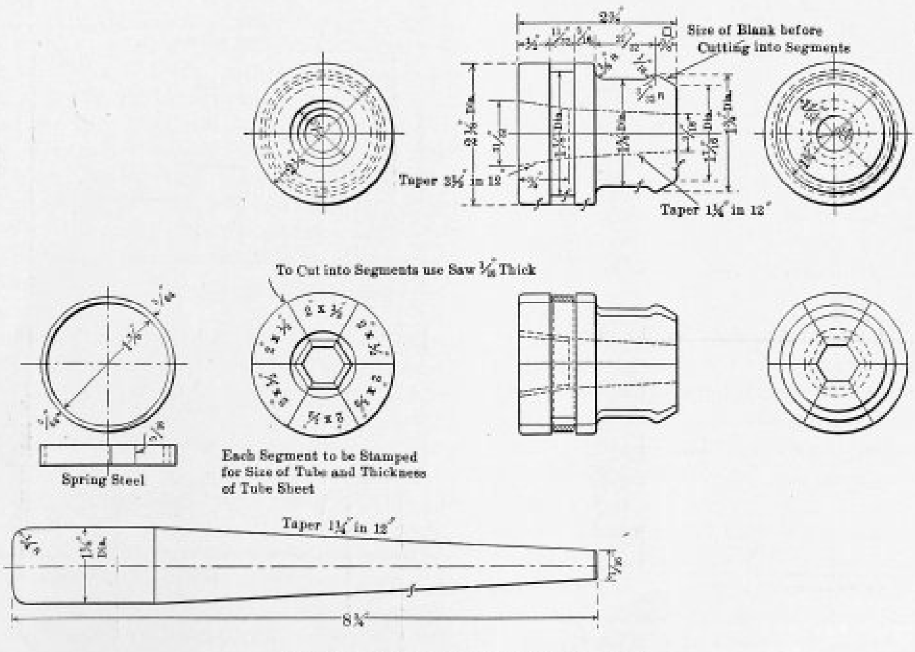


FIG. 7.—PROSSER FLUE EXPANDER, 2" X ½".

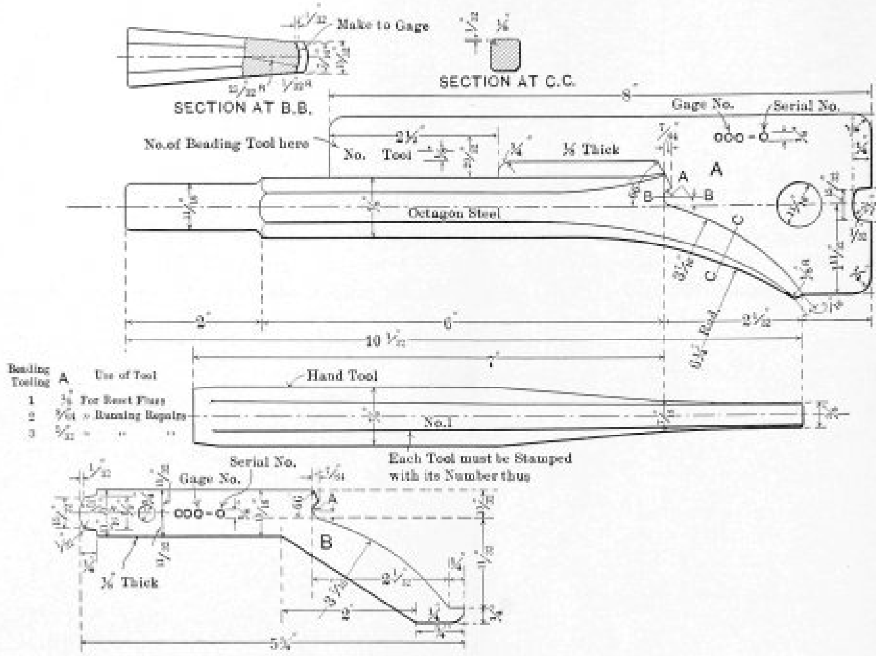


FIG. 8.—BEADING TOOL FOR BOILER TUBES.

(5) Flue to be beaded with standard beading tool No. 1, Fig. 8.

Front End—(6) Front end of flues to be opened to fit the holes in the front flue sheet with a tool provided for that purpose, Fig. 4, except where the flues are applied without the re-

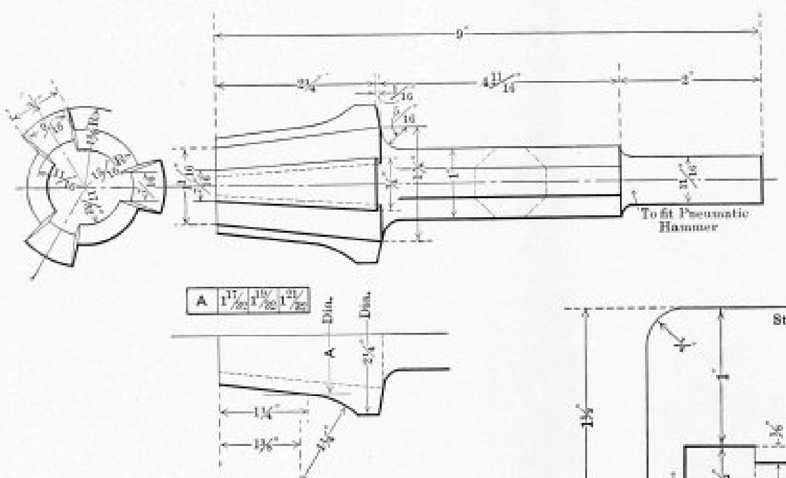


FIG. 10.—SPREADING TOOL.

moval of steam pipes, at which time flues will be opened with a plug pin after the flues are applied to the boiler. Flues to be rolled with an air motor and standard roller expanders, and all beaded with standard beading tools.

The method of handling the enlarged holes used for transfer purposes was given in a previous issue of THE BOILER MAKER.

The maintenance of flues in service is covered by the instructions following, and beading is to be done with either of tools No. 2 and No. 3, as the bead requires. The prosser expander is to be generally used, only that in case of weak flues, when flues would be liable to burst under the prosser expander, the roller expander may be used.

MAINTENANCE OF FLUES IN SERVICE.

(1) Flues must be worked over at every washout, and there shall not be a lapse of more than thirty days between each period of working over. Local boiler inspectors must examine the flues both before and after working over.

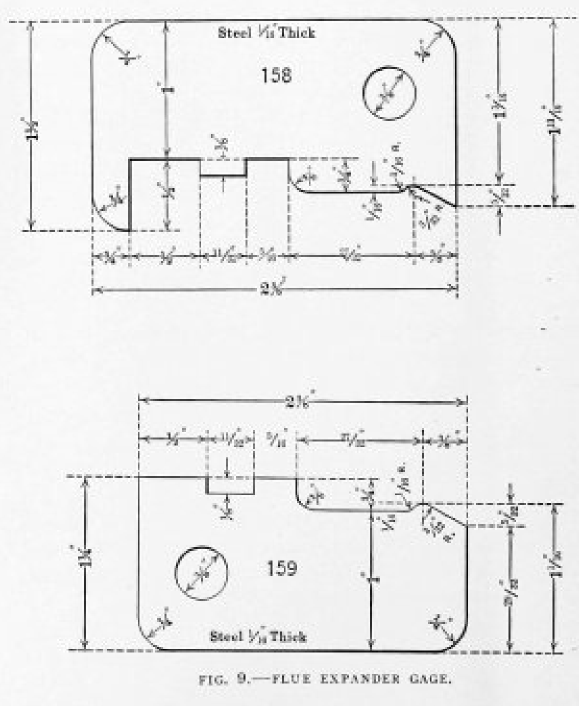


FIG. 9.—FLUE EXPANDER GAGE.

(2) Positively no flues shall be allowed in service with the beads off.

(3) The plugging of flues or the use of thimbles to strengthen the same is positively forbidden.

(4) Where flues require a thorough working over the boiler shall be relieved of pressure before the work is performed.

The standard self-feed rollers are of the company's own design, and I believe equal to any on the market for general serviceability.

The greatest cross-section dimension on the 1⅝-inch rollers used in the fire-box end on 2-inch flues is but 2⅝ inches, and so extends past a 2-inch hole but 5/16 inch on either side, thus making a good roller for close quarter work on the outside rows of flues next to the flanges. It will be noted that the chemical composition of the tool calls for good quality steel.

Prosser expander gage No. 158 (Fig. 9) and beading tool gage "A" (Fig. 8) are for the use of the inspectors and foreman to check the tools and see that they are kept to gage.

The master gage "B" (Fig. 8) and No. 159 (Fig. 9) are a check on the gages and for use of the general foremen boiler makers, general tool-room inspectors and those who are required to know that the standards are maintained.

All flue tools are required to be turned into the tool room nightly, and are checked by gages before being again put into service.

NICKEL STEEL RIVETED JOINTS.

Dr. Ernst Preuss has recently conducted at the Technical University of Darmstadt an extensive experimental investigation of the strength of nickel-steel riveted joints with special reference to resistance to slip. The results of these tests have been published in the form of a report containing some 80 pages, the principal features of which are outlined by the *Engineering Record* as follows:

The tests comprised sixty-five single-riveted and five double-riveted lap joints and fifteen single-row butt joints of soft steel having an ultimate tensile strength of about 57,000 pounds per square inch, with nickel-steel rivets. For comparative purposes eight single-riveted lap joints with wrought iron rivets were also tested, and reference is made to the work of many other investigators, notably von Bach's tests of 300 wrought iron riveted joints made about twenty years ago. The joints were, in fact, designed as nearly as possible like those used by von Bach, with a view of establishing a direct comparison between nickel-steel and wrought iron rivets.

The nickel steel for the rivets was of four different compositions, the nickel ranging from 3.2 to 4.0, the carbon from 0.1 to 0.36 and the manganese from 0.35 to 0.8 percent. The limits for phosphorus and sulphur fell within 0.01 and 0.03 percent, respectively. The rivets were 16, 19 and 25 millimeters (⅝, ¾ and 1 inch nearly) in diameter, and were driven by hand, hydraulic and electro-hydraulic presses and pneumatic presses and hammers.

The plate varied in width from 162 to 288 millimeters (about 6½ to 11⅜ inches), and in thickness from 8 to 18 millimeters (5/16 to 11/16 inch), the rivet pitch ranging from 52 to 107 millimeters (about 2 to 4¼ inches). The rivet holes were all drilled from the solid. The single-riveted lap joints contained three rivets, the double-riveted lap joints five rivets, and the butt joints two rivets in a single row to either side of the joint.

The physical properties of three of the four kinds of nickel-steel showed a fair agreement, the ultimate tensile strength ranging from about 73,000 to 80,000 pounds per square inch, the yield point from about 51,000 to 68,000 pounds per square inch, the elastic limit from about 43,000 to 48,000 pounds per square inch, and the shearing strength from about 105,000 to 118,000 pounds per square inch. The fourth kind of nickel-steel, made in the electric furnace, was, however, of a wholly different character, the ultimate strength being over 50 percent higher, the elastic limit somewhat lower than the values above quoted, and the shearing strength averaging 142,000 pounds per square inch. It was also deficient in ductility, and, in fact, so brittle that, especially in the lap joints, the rivet heads broke off before the shearing strength of the shank had been fully developed. It is particularly noteworthy that the above shearing values for nickel-steel are about 40 percent higher than the tensile values, whereas the shearing strength of carbon steel is usually 10 to 20 percent lower than its tensile strength.

Observations on the frictional resistance to slipping of the plates were made with extraordinary care by means of a very sensitive mirror-reading apparatus, and it was found that the slip, partly elastic and partly permanent, began asymptotically at loads much below the working loads of the joints, whereas von Bach observed no slip up to loads about 50 percent above the working loads, and then a sudden slip under slightly greater loads.

The ultimate strength of the nickel-steel riveted joints was found to be about 2 to 2¼ times as great as that of joints riveted with wrought iron or mild-steel rivets. As regards slip, nickel-steel and wrought iron rivets were found about equally effective at low loads, whereas for high loads the slip for nickel-steel rivets was decidedly less. The slip was not influenced in any marked degree by the method of riveting, but rather by the condition of the surfaces and by the length of time the die remained pressed on the rivet head. The remarkable toughness of the material was shown by the fact that the heads of the ⅝-inch rivets were pulled through plates 5/16 inch thick, in the tests of lap joints, by shearing out the metal in the plate with little damage to the rivet heads. The author therefore suggests that in the case of thin plates the heads of nickel-steel rivets might advantageously be enlarged to guard against this form of failure. The slipping of the butt joints was greater than that of the lap joints of the same ultimate breaking strength, notwithstanding the fact that the surface under fricion is relatively greater in the former. This is presumably attributable to the circumstance that the bending of the lap joints tends to intensify the pressure at the surfaces in contact. The author calls attention to the fact that the resistance to slip of multi-riveted lap joints is relatively lower than that of single-riveted lap joints, because the frictional resistance cannot be assumed as equally distributed over all the rivets.

For effective riveting it is obviously important that the material should possess, not only a high shearing strength, but also a high yield point at high temperatures, so that elastic stresses can be developed in the shank at an early stage in the cooling process. The author accordingly instituted tests on the yield point, as well as the ultimate strength of nickel-steel, up to about 1,100 degrees F., which showed values for the former fully twice as great as those obtained on wrought iron by Rudeloff up to temperatures of about 750 degrees F.

The joints were designed so that the ultimate shearing strength of the rivets was equal to the ultimate tensile strength of the net section of the plate. Failure took place by tension in the plate, shearing of the rivets, shearing out of the rivet holes, pulling of rivet heads through the plates, and in some cases by the breaking off of rivet heads.

The author recommends that advantage be taken of the superior shearing strength of nickel-steel rivets by reducing the diameter rather than increasing the pitch of the rivets as the best means of securing tight joints. Obviously, a reduction in the number of connection rivets for a given member leads not only to a corresponding diminution in the size of the connection plates, but is also calculated to ensure a more nearly uniform distribution of the stress upon the rivets. It is somewhat remarkable that in Dr. Preuss's discussion of the factors entering the design of riveted joints, no reference is made to bearing, which is apt to be a governing element in the design of butt joints for plates of ordinary thickness, even where the rivets and plates are both made of like material. In the case of nickel-steel rivets and carbon-steel plates obviously the limits within which the bearing of the rivets would govern rather than their shear, are much increased. This phase of the subject, that is to say, the determination of the conditions under which initial failure would be brought about by the permanent elongation of the rivet holes, is, therefore, a most important one, to which little prominence has been given in the tests under consideration.

It is interesting to recall in this connection that in Mr. Modjeski's report upon the Manhattan Bridge, reference is made to recent tests on nickel-steel riveted joints made for the Board of Engineers of the Quebec Bridge, which showed that their ultimate shearing strength exceeded that of carbon-steel riveted joints from 8.4 to 22.7 percent, with an average excess of only 16.4 percent; also that in joints of about the same thickness as those in the chords of the Manhattan Bridge, the first slip of the plates was detected at from 9,500 to 14,670 pounds per square inch of rivet in field-riveted joints, and from 10,500 to 18,000 pounds per square inch of rivet in shop-riveted joints, the field riveting being done by a pneumatic hammer, and the shop riveting by a pressure machine, whereas a shearing stress of 20,000 pounds per square inch of rivet is allowed by the specifications for that bridge. Mr. Modjeski states that it is quite possible that stresses greater than those required to produce an initial slip will be of frequent occurrence in some joints, and that in consequence the rivets in members subject to reversal of stresses may gradually become loose and require replacement, a condition which might have been avoided by the selection of a more conservative unit stress. By way of comparison it may be stated that the specified unit stresses for rivet shear in the Municipal Bridge at St. Louis, now in course of fabrication, are 10,000 pounds for carbon steel and 14,000 pounds for nickel-steel for power-driven rivets. For hand-driven rivets these values are reduced to 8,000 and 11,200 pounds, respectively.

BOILER EFFICIENCY AND SAFETY.

It is a remarkable fact that keen business men who generally exercise the greatest possible care in the choice of plant, the adoption of labor-saving devices, and in the matter of working expenditure should be so blind to the loss which is daily occurring in the generation of mechanical power in the factory. It is certainly a fact that in most boiler installations there is not only great thermal loss owing to the neglect of taking reasonable steps for supervision and general maintenance, but the methods of construction are often such as to render inspection both difficult and costly.

A proper scientific test of a boiler for thermal efficiency entails considerable trouble and expense, but if carried out would often startle the proprietor and lead to immense saving in fuel expenditure. The amount of heat unnecessarily allowed to escape up the chimney, and thus unabsorbed by the boiler, is far larger than is generally realized. The causes of this waste are mainly three, viz.: *Accumulation of soot, cracked brickwork and too large a surface of brickwork in contact with the boiler.*

With the old methods of setting boilers in thick brickwork it is not an easy matter to clean the flues, while inspection of a large portion of the external surface is impossible, the brickwork, too, being rigid does not expand with the movement of the boiler and cracks are inevitable. The loss of heat through the inrush of cold air into the flues is sometimes enormous.

The number of explosions caused by wasting concealed under brickwork have lead to some severe strictures being made by the British Board of Trade Commissioners, appointed to make investigations under the Factory Acts on the neglect of boiler owners to remove brickwork for thorough examination, and in

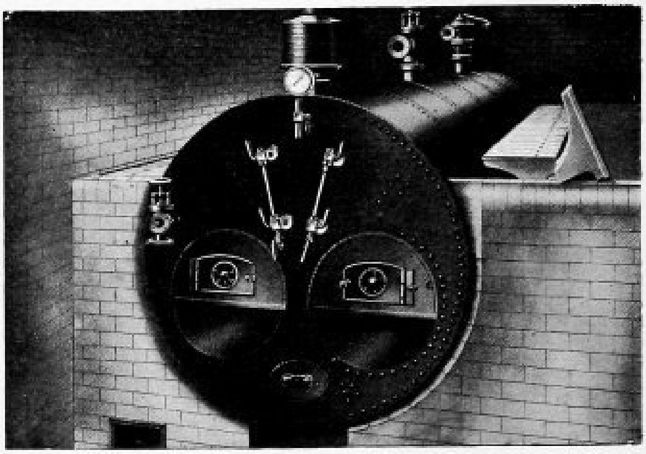
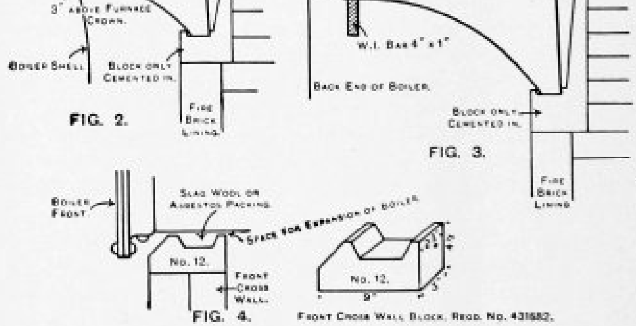


FIG. 1.—ADJUSTABLE COVER BLOCK APPLIED TO LANCASHIRE BOILER.

recent investigations heavy penalties have been imposed where such neglect to bare the plates has been observed.

During a recent inquiry in England it was shown that although an examination of as much of the plate surface as possible had been revealed, yet after the explosion it was found that the plate where the fracture occurred, and which had been concealed for thirty years in brickwork, was no thicker than brown paper, and the soil near the same part of the boiler was found to be quite damp. The commissioners pointed out that it was perfectly obvious that examination of the plates beneath



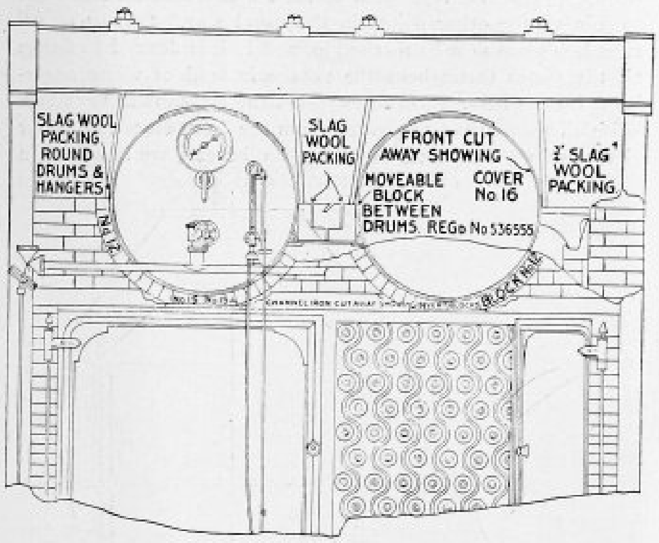
DETAILS OF ADJUSTABLE COVER BLOCK.

the brickwork ought to have been made, and that the policy of not removing brickwork unless some suspicion arose was not a sound one in the interests of the public.

It will, therefore, be seen that one of the most fruitful causes that have led to boiler explosions has been the inability to make a thorough examination of the external surface of the plates by reason of the brick setting being made a permanent job, and although every owner and boiler insurance company is aware of the importance of a periodical inspection, the work is often neglected owing to the expense and inconvenience caused in the works through the closing down of a boiler.

More stringent regulations have recently been put in force in Great Britain, and from time to time no doubt the regulations in the United States will also become more severe. Within the last three years several important improvements in boiler setting have been effected to meet these more stringent requirements, and a British company—the Adjustable Cover & Boiler Block Company, Ltd., of London—has placed on the market a number of patented designs for this purpose. We understand they are about to introduce this system into this country, and we are indebted to Mr. P. E. White-Hurst, 500 Fifth avenue, New York, for the following information regarding their method of setting boilers.

We reproduce views of two types of horizontal boiler showing their patented adjustable flue covers in contact. The sectional drawing, Fig. 2, shows the covers used for closing in the side flues. They consist of a series of firebrick covers which



FRONT ELEVATION BABCOCK & WILCOX BOILER, SHOWING PATENT "ADJUSTABLE" FLUE COVERS & BLOCKS.

FIG. 5.

rest in a block, or seating, of similar material. The blocks are constructed so as to allow the covers freedom to take up the expansion and contraction of the boiler, and the former alone are cemented into the brickwork, the removable covers being held by means of packing inserted at the back, this forming an air-tight joint. A thin wash of fireclay cement prevents leakage from the rebated joints without affecting their removability.

Fig. 3 shows the same principle applied to the down-take covers, and in this case the ends of the covers which touch the back of the boiler are supported on the wrought iron bar shown in the section.

Fig. 4 shows the special design of front cross-wall blocks, which also absorb the expansion and contraction of the boiler.

The front wall with the removable blocks is built so that there is about ¼ inch clearance between the blocks and the boiler shell, and packing is placed in the hollow recess thus formed.

It is claimed that no boiler explosion has occurred where this system has been installed, owing to the facilities for inspection; also that the saving of time, expense and labor is enormous, and that the maximum of plate surface is exposed to the heated gases, and fuel is economized through having gas-tight flues.

A Commendable Practice.

It has long been observed that the majority of boiler explosions happen in the morning just after the load has come on, frequently on Monday morning, after the boilers have passed through a period of idleness. During this period they have been under the care of watchmen and helpers who, of course, are not experienced engineers. The night watchman, having orders to have steam raised at a certain time in the morning, brings the pressure up regardless of any engineering precautions which, with the regular men in charge, are observed as a matter of course; and owing to the lack of exhaust steam during the early morning hours the feed water is frequently pumped into the boilers cold while the fires are being pushed to get steam up to the prescribed point before the day watch comes on.

There is no doubt that this firing-up time is the crucial point in the daily experience of a steam generator, which repeated day after day must surely have an influence on its structure, and if the truth were known it would probably be surprising to see how much abuse the average boiler stands in its lifetime.

It is a pleasure, therefore, to cite the practice of one engineer who appreciates the extent to which unequal expansion and contraction in firing up can cause trouble in boilers. This man is of the opinion that engineers do not always realize the long time it takes to get the water in a boiler heated to a uniform temperature, even in those boilers which are generally supposed to have good circulation. He is in charge of a battery of boilers in which he had noticed that as long as one hour after raising steam to 100 pounds, the working pressure, cold water could be drawn from any one of the bottom drums, which would be cool enough to drink. To avoid this condition, before firing up he would raise the water level one gage higher than required when running, and when 5 or 10 pounds of steam showed on the gage he would blow down to the regular level. This emptied the lower drum of all cold water and immediately brought the boiler and contents to a uniform temperature, after which steam could be raised as rapidly as desired. This is a little part of routine management that has fully repaid the trouble taken to keep it in force, as not 1 cent has been expended on these boilers since they were put in.

This engineer previously had charge of a battery of return-tubular boilers fitted with mud drums. The practice above outlined was used here also, and in thirteen years not a tube had to be expanded nor a cent expended for repairs on these boilers.

The most careful and intelligent handling is necessary to get the best results with any boiler, and it is difficult to overdo this feature; in fact, it is better to spend a couple of minutes a day in being too careful than to spend a lifetime of regret over not being careful enough.—*Power and the Engineer.*

Fatalities due to Locomotive Boiler Explosions During the Period July, 1904, to June, 1909, Inclusive.

Time.	Trainmen, Killed.	Trainmen, Injured.	Other Employees, Killed.	Other Employees, Injured.	Total Employees, Killed.	Total Employees, Injured.	Other Persons, Killed.	Other Persons, Injured.	Grand Total, Killed.	Grand Total, Injured.
July, 1904, to June, 1905.....	38	564	10	53	48	617	....	8	48	635
July, 1905, to June, 1906.....	45	610	1	41	46	651	....	1	46	652
July, 1906, to June, 1907.....	70	768	7	67	77	835	....	6	77	841
July, 1907, to June, 1908.....	54	767	4	56	58	823	....	3	58	826
July, 1908, to June, 1909.....	33	655	3	55	36	710	....	2	36	712
Total	240	3,364	25	272	265	3,636	....	20	265	3,656

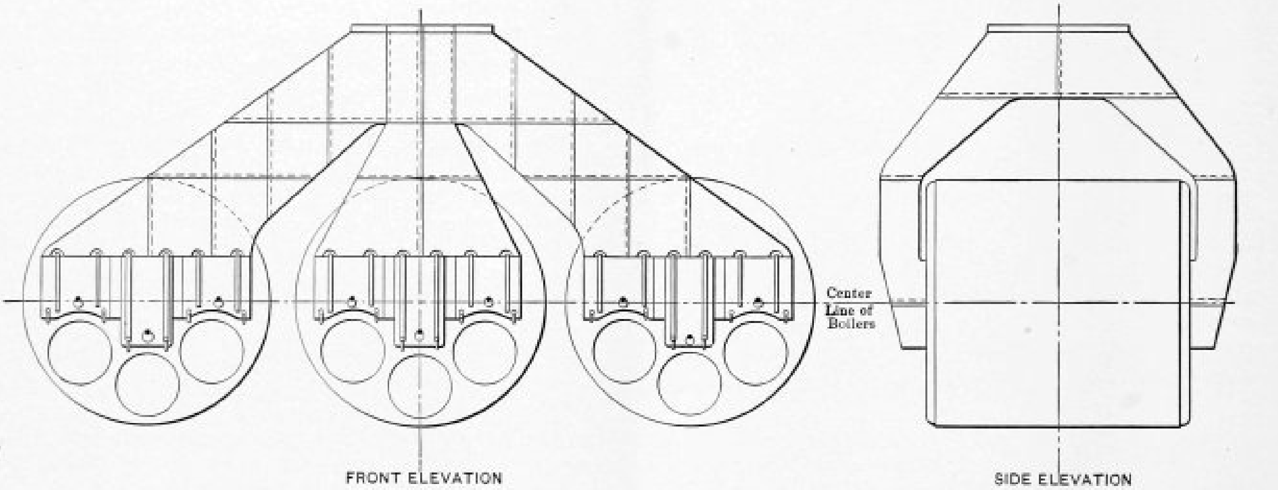
THE LAYOUT OF AN ARCHED SMOKE BOX.

BY EVAPORATE.

Some time ago we had a smoke-casing to construct for a group of boilers—three in number—placed three in line athwartship. The boilers were of the double-ended type, or as they are familiarly called, "fore-and-aft" boilers, and were 17 feet 3 inches long by 15 feet diameter, each having six furnaces.

The space required for the layout of this job was very great, and as our drawing board was rather "circumspect" we could not even find room enough for a full half-front elevation and a half-side elevation, and we had to content ourselves with placing one drawing on top of the other, using white chalk for the front elevation and red chalk for the side elevation. To proceed with such an arrangement ought not to present any serious complications to a careful layer-out, but for illustrating purposes it will be necessary to use both drawings separately.

Let us draw a half-front elevation and a half-side elevation, as shown in Fig. 3, and proceed to layout the plates for the the lath at the center line, again mark the intersecting points (this time marked by 2, 2, 2), and repeat this again on line 3, and so on, till line 11-11 is reached, where there is only one point to mark. Now proceed to transfer these points on to their corresponding lines, as marked on your plates, commencing, naturally, with line 1. The whole operation is simplicity itself, for with the precise position of the lath, with its end to the center line (on front elevation), mark the points numbered 1, and on line 2 at the corresponding number on the wood place the mark 2. Similarly with lines 3 and 4 until line 10-11 has been reached, always taking care that the end of the lath is on the center line. Now draw in arcs marked *E* and *F* on Fig. 3. As can be seen, part of uptake between points 1 and 2 is directly perpendicular. It follows that its true shape will be similar to the drawing. Join points 1 and 2, and then proceed to join all the other points in the usual way. (Fig. 4.) All rivet holes can now be marked in, and if it is desired to flange all the plates throughout the uptake instead of using angle-bars for corners, allowances for flanging should be made. With all the marks transferred from the front elevation to our plates and all our points connected up thereon, we have now a



THE ARCHED SMOKE-BOX AS IT WILL APPEAR WHEN COMPLETED AND INSTALLED.

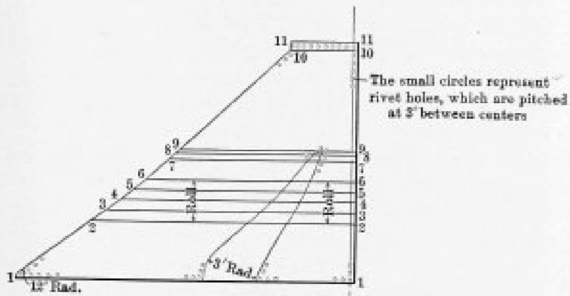
fore-and-aft ends of the smoke casing. Divide the arc *A B* (Fig. 3), side elevation, into any number of equal parts—say four—and through each of the divisions or intersections draw a line at right angles to the vertical center line and parallel to each other, and on the front elevation divide the arc *C D* into any number of equal parts—say two—and again draw or strike lines through the intersections of the arc. With these preliminaries we have obtained all of the lines necessary for the layout of all the plates of the fore-and-ends.

Now place the plates in position on the trestles with the required laps on each plate (for joints), and with a chalk line strike the line 1 (Fig. 4) at the bottom side of plates. Then with the trammels draw in the center line perpendicular to the base line, and along the center line measure in points through which lines 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 will pass. Then draw in these lines parallel to the base line, at distances corresponding to those between 1 to 2, 2 to 3, 3 to 4, 4 to 5 (side elevation), and so on till line 11 is reached. Now take a narrow strip of wood, a lath of wood, preferably the length of line 1 (front elevation), Fig. 3, and noting to keep your lath on the center line, make the three points of intersection (*i. e.*, points marked 1, 1, 1) on the lath, and just where your mark occurs on the wood carefully place the number of the line, in this instance 1. These numerals must be carefully inserted or confusion would inevitably follow. Proceed to line 2, and holding half-front pattern for either the "fore" or "aft" end, and it will be necessary here after punching or shearing the plates to mark one plate off each of the templets thus obtained, and then two plates off each with the templet turned upside down, thus securing "rights" and "lefts." Note that the center line on the plates is the center line of rivet holes for lap jointing. Now remove all working lines from the drawing board, and proceed with the laying out of the arch back, extending from the "fore" to the "aft" end of the boilers. Divide arc *E F*, side elevation, Fig. 5, into any number of equal parts, say two. Then divide arc *G H* into any number of equal parts, say two, and divide arc *I J* into any number of parts, in this case also two. Now draw lines through all these points parallel to the horizontal center line and extending from the arch back, side elevation, across the front elevation. These are the lines necessary for the layout of the arch back.

Layout the plates for one-quarter or one-fourth of the arch in the same way as was done with the front ends, attention being given to laps, etc. Draw a line along the bottom edge of the plates and erect a perpendicular center line. Now strike a line, distant from the base line, equal to the breadth of the flange, which meets face of boiler, and proceed to lay down the lines 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11, the pitches of which are obtained from the side elevation, equal to the distance from points 1 to 2, 2 to 3, 3 to 4, 5 to 5, 5 to 6, 6 to 7, 7 to 8, 8 to 9, 9 to 10, 10 to 11, the point represented by 11 being the center of the arch.

Now take a lath of wood, and apply it as in the case of fore ends, again noting to keep the wood just over at the center line, and mark on it the points of intersection, three of which occur on line 1. Then proceed upwards to line 2. Mark the points of intersection, and so on, 3, 4, 5, 6, 7, 8, being treated similarly (9, 10 and 11 have only one point of intersection), 10 and 11 being same length.

It is obvious that care must be taken in marking the lath while lifting the various points, as the success or failure of the whole thing depends on the care expended on these points.



PLATES FOR FORE AND AFT ENDS
Fig. 4

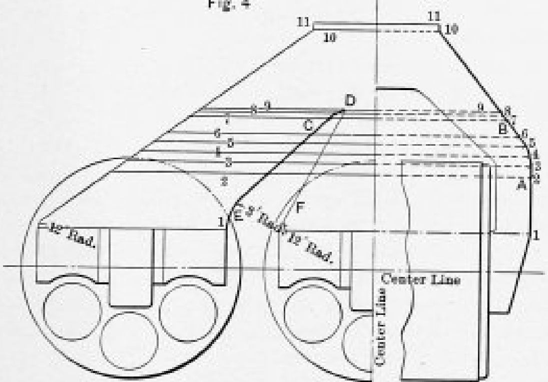


Fig. 3

LAYOUT OF FRONT PLATES.

Now proceed to transfer the points or marks just obtained on to the corresponding line already placed on the plates (Fig. 6), commencing at line 1 and working upwards to line 2, then lines 3-4, etc., marking the three points on each line. Lines 8, 9, 10 and 11 have only one point on each, while line 11 represents center of rivet holes. The arcs may now be drawn in. The radius given on the drawing is the correct one, since the part of uptake between lines 1 and 2 is perpendicular. The true shape of the curve is that shown on the drawing. Join the top of the arcs to line 2, and through all the points on lines 2, 3, 4, 5, 6, etc., draw a line or lines as shown in Fig. 6.

The quarter pattern for the arch back is now complete, and to secure "rights" and "lefts" it will be necessary to mark one plate off each templet and two off the "other side up."

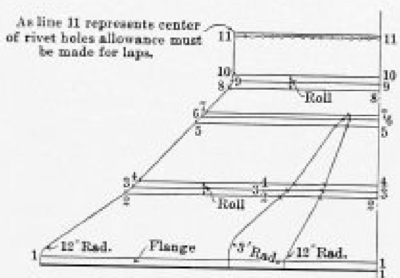
Now remove all working lines from the drawing and proceed with the new lines for the development of the port and starboard, outer and inner sides, as well as center sides and bottom plates. Divide arc *K*, Fig. 7, at the bottom of the center nest of tubes into two equal parts, and divide arc *L* into any even number of equal parts, as it is necessary, or at least desirable, to have a point at the top center of this arc; in this case we will make four equal divisions. Then divide arc *O* (front elevation) into two equal parts and arc *P* (side elevation) into two equal parts. Now draw lines through all these points extending across the front and side elevations, as shown in Fig. 7.

We will commence to layout the various plates, taking the bottom plates first. First, square one end of the plate and strike line 1, say 1 inch from the edge of the plate. Then draw in lines 1, 2, 3, 4, 4, 5, 6, 5, 4, 4, 7 at pitches equal to the distances from 1 to 1, 2 to 2, 2 to 3, 3 to 4, 4 to 4, 4 to 5, 5 to 6, 6 to 5, 5 to 4, 4 to 4, 4 to 7. Line 1 is the center of holes for the lap joint, and line 7 is also the center of holes for joints with side plates. Now, with a short lath of wood, keeping one end of the lath on a line representing the face of the boiler (side elevation), mark on the lengths of lines 1, 2, 3, 4, 5, 6 and 7 in their respective places.

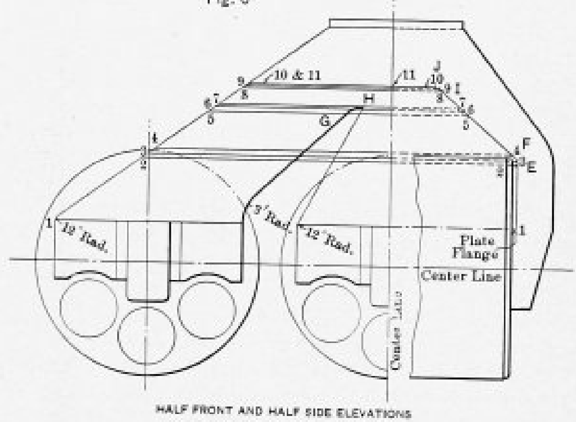
Lay out these sizes on the plates at the lines 1, 2, 3 and so on (Fig. 8), and through the points on the respective lines draw a line or a fair curve, which operation will complete the templet for all the bottom plates—twelve in number—and when punching and shearing of the templet has been performed five plates will be marked "right side up," while the other six will be marked from the templet turned upside down or reversed, thus securing "rights" and "lefts."

We will now lay out the plates for one-half of either the port or starboard outer sides, allowance again being made for lapping for joints.

Lay out the center line (Fig. 9), and commencing at the top of the plates this time, draw line 21 at right angles to the



¼ PATTERN FOR ARCH BRICK
Fig. 6



HALF FRONT AND HALF SIDE ELEVATIONS
Fig. 5

LAYOUT OF BACK PLATES.

center line. Then draw lines 20, 19, 18, 17, 13, 12, 11, 10, 9, 8 and 7 (notice to omit lines 16, 15 and 14, as these are working lines for the inner side and will be required later).

The pitches of the lines along the plates are obtained by measuring the distances from points 21 to 20, 20 to 19, 19 to 18, 18 to 17, 17 to 13 (center line, front elevation). Note line 7 represents the center line of the rivet holes for jointing the bottom in a manner similar to that employed in transferring lengths on other plates. Proceed to lift the true lengths of lines on to the plates, beginning at line 21 at the top of the side elevation, Fig. 7, keeping the end of the lath at the center line. Mark 21 at the extreme length and similarly line 20. Lines 19, 18, 17 must now be marked, and these have two intersections each. Pass over lines 16, 15 and 14, meantime, and at lines 13, 12, 11, 10, 9, 8 and 7 mark the lath at two different places on each line, carefully noting to neatly insert the number of the line on the lath immediately over the points representing the lengths of lines. Line 7 is, again, the line for rivet holes for the junction with the bottom plates.

Now transfer all these points to the lines on the plates, each at its respective number, and when all the lengths have been laid out join the points as in the previous case. There being four *other* sides it will be necessary to mark one plate off similar to the templet and two with the templet reversed, thus forming "rights" and "lefts."

Now proceed with the plates for the inner sides. Lay out the plates as in the outer sides. Strike a center line and draw line 16 at right angles to the center line at the top edge of the

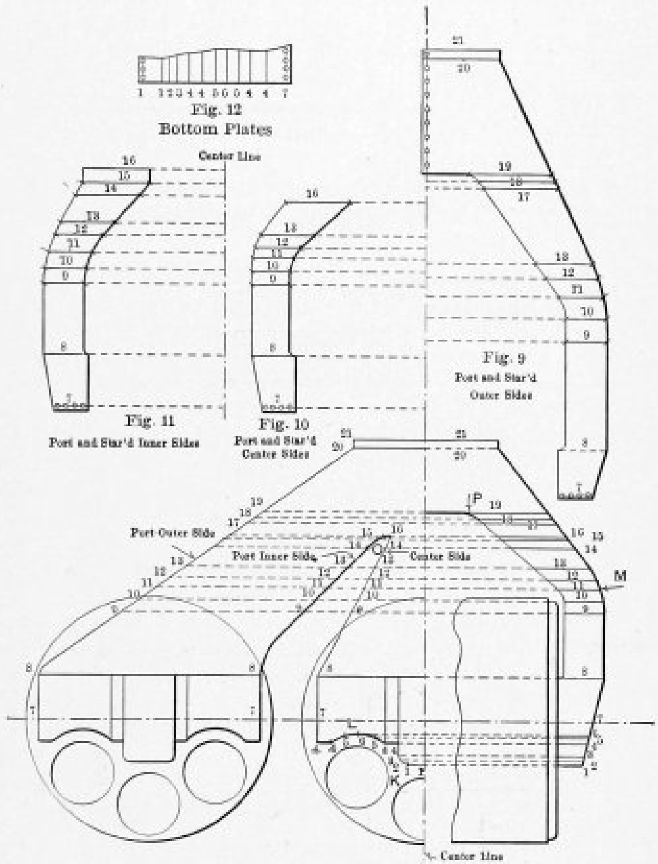


FIG. 8.

plates. Now draw lines 15, 14, 13, 12, 11, 10, 9, 8 and 7 at pitches equal to the distances between these lines on the "front elevation," Fig. 7, on a line representing the *inner* side. Take the measuring lath again and mark on it the lengths of lines 15, 14, 13, etc. (side elevation). Now transfer these marks to the corresponding lines on the plates, Fig. 11. Join all these points as shown. To complete the inner side mark one plate off the templet, two of the templet reversed, again securing "rights" and "lefts."

The developing of the *center* sides is practically a repetition of the work done on the inner and outer sides. Fig. 10 shows the developed plate, which was obtained in practically the same manner as those previously described.

This completes the development of all the plates for our up-take, as shown in Figs. 1 and 2, except the door plates, which require little or no developing. Baffle plates will, of course, be required for such a casing, and these can be quite easily "lifted" from the templets of the smoke-casing proper, before this has been spaced for riveting. Angle-bars, when these are used, are sometimes developed, too; that is, they are laid along the edge of the plate to which they are finally to be attached before the plates are bent, and then the bending is done in practically one operation. The quality of the steel plates used in this class of work has improved so much recently that the practice of flanging the edges of the plates has become quite common, and this method has many obvious advantages.

DUPLICATING AN OLD FLUE SHEET.

BY J. N. HELTZEL.

A very essential and yet one of the most vexatious jobs that confronts a layerout in a railroad shop is the task of duplicating an old flue sheet; that is, to complete the sheet with all holes so that it may be put in place without removing it to punch the holes and, at the same time, secure a neat fit with fair holes. It is a well-known fact that when new boilers are built it is very often necessary to make some alteration in order to overcome some error. This error may be in the drawing, or the layerout may make a mistake. He may have the wrapper sheet too long or short; in either case it will necessitate the altering of the flange of the flue sheet. In this case the flue sheet will be either larger or smaller than the drawing calls for, which will not be detrimental to the boiler, however, but will be a source of annoyance in future when a new flue sheet is required.

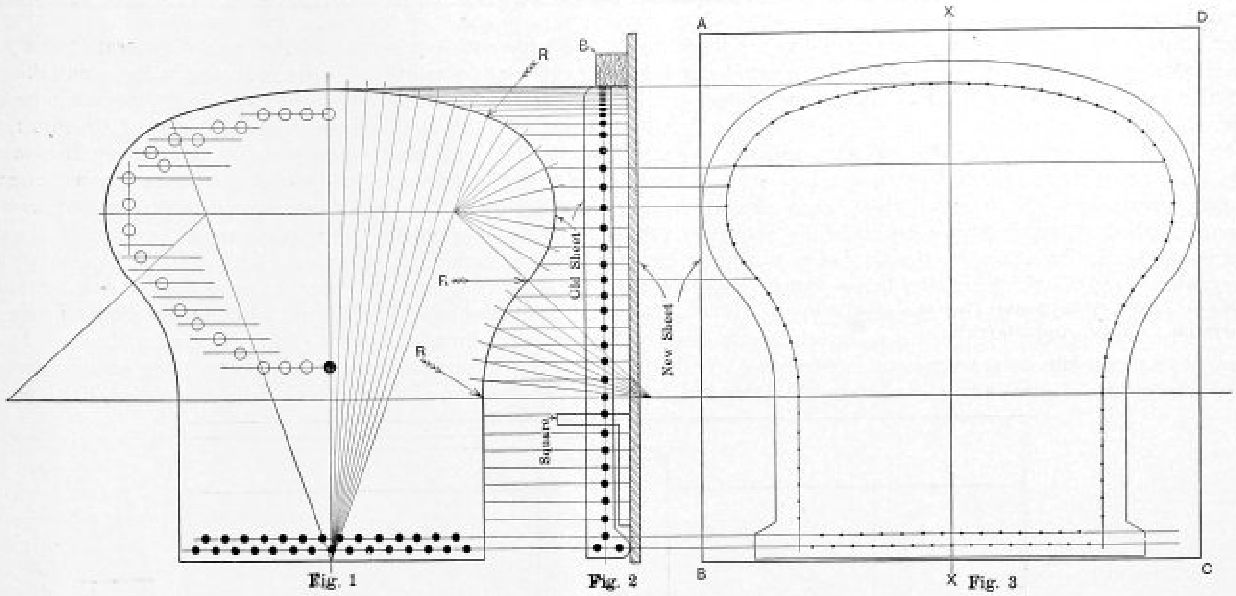
If the new sheet is laid out by drawing, there are various ways in which it may vary from specifications. A mistake may be made in ordering material—say the wrapper sheet may be ordered 1 or 2 inches short. Instead of ordering a new sheet the firebox may be made to suit conditions, and this would mean that the flue sheet will be somewhat shorter than specified. Notwithstanding the fact that the alteration is approved by the purchaser, a record is not kept, nor is a note made on the drawing that would materially aid someone in future. Deviations such as the foregoing are the cause of considerable annoyance when repairs are necessary, such as the renewal of the flue sheet.

Assuming, however, that a sheet is originally precisely like the drawing; when this same sheet is removed, after having been in service, it will be found to have changed, because the rolling of the flues has expanded the sheet, and in some cases I know a difference of ¼ inch has been caused by working of flues. In view of the foregoing conditions it is evident that the blue print should not be followed except to a limited extent, for flue spacing only. It is good practice to check the old sheet with the print, because there may have been an error in the old sheet. However, the only unfailing way to duplicate an old sheet and lay out all the holes in the flange is illustrated in Figs. 1, 2 and 3.

The method here described is not a scientific one, and may appeal to the reader as old-time practice, and perhaps many would prefer using a more scientific method, such as by means of the blue print and trams. The one who uses the scientific method, the blue print and trams, without referring to the old sheet, is usually the one who feels small when the attempt is made to apply the new sheet. Usually it will not fit.

Fig. 1 represents an old flue sheet. Fig. 2 is same sheet laid flange down to the new plate out of which the new sheet is to be made. The location of the holes in the flange is shown in either figure. The reader can estimate the importance of having the holes in the new sheet in exactly the same location as in the old sheet, and this is accomplished by this method.

It is obvious that if a hole is located at a point tangent to two curves, as at *R*, Fig. 1, the holes must be in the same location in the new sheet, or they will not correspond. Draw line *x-x* in the center of the sheet, Fig. 3; locate the center of



METHOD OF LAYING OFF A NEW FLUE SHEET FROM AN OLD ONE.

the old sheet top and bottom. Place same as shown on Fig. 2. The face of the flue sheet must be blocked up parallel with the new sheet. Scribe the curvature of the sheet by using block *B* or some other convenient tool. After the flange line is marked off use a 2-foot square in the manner shown in Fig. 2, locating all rivet centers on the flange line as shown on the sheet, Fig. 3. The center thus found will be the flange line. Every alternate center is then marked heavy with a punch, every alternate mark being centered light. The necessary allowance for the flange is then added, also the center lines of the mud-ring rivets are squared from the old sheet the same as other centers. These holes may be stripped off by using the center of the sheet as a fixed point. All flue holes are laid out to point, also the brace and stay-bolt holes; but is it good practice to check by the old sheet? After the sheet is flanged accurately to mark, annealed and straightened, the rivet line is drawn around the flange according to the old sheet, and all holes located on this line by squaring the center or flange marks from the face sheet by using a 2-foot square.

If the foregoing method is used no trouble will be experienced in securing a good fit with fair holes. The sheet may be completed on the floor, and the extra labor of fitting the sheet for the purpose of marking holes is eliminated.

Internal Feed Pipes.

The boiler of a small tug (an ordinary Scotch, with a single furnace) had been troublesome for a long time through priming badly—almost continuously with dirty or sea water. The main check valve was on the front of the boiler at about the level of the center line of the furnace and had no internal pipe, the boiler being too small for a man to get down between the tubes and shell to fit one.

The valve was taken from the front and fitted on the back of the boiler and an internal pipe fitted, with one row of holes having about 25 percent more area than that of the pipe. The pipe was fastened so that the *water was delivered towards the front or smoke-box end of the boiler.* We found the position of these holes a very important matter, as by giving the cross-pipe half a turn, to make it discharge towards the combustion chamber, the boiler primed again so much that the boat had to pull up, and we had to lower the steam and fix the pipe to discharge as at first. Ever since it has been found to be practically impossible to make her prime.

In another steamer, the check valve was on the side of the shell, about level with the third row of tubes from the top—

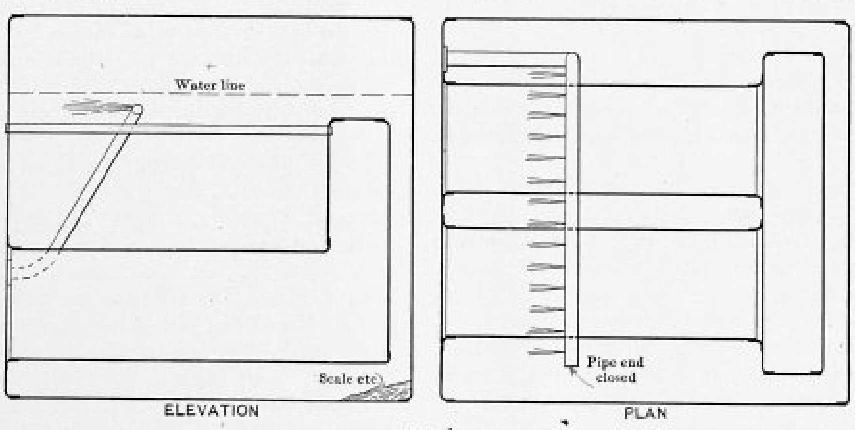


FIG. 1.

The majority of boiler tube failures are probably directly due to scale, sediment, oil or some foreign matter inside the boiler. Restricted circulation and unequal expansion and contraction, however, have considerable effect on the life of flues.

no internal pipe was fitted. As there was always a certain amount of dirt among the tubes opposite the check, we decided to fit a pipe similar to the first case; and on opening the boiler about ten weeks afterwards we were pleased to find it much cleaner than usual everywhere (the engineer said dirt had shifted that he had been trying to get rid of ever since joining the ship), all the loose dirt being heaped up on the bottom of the shell at the back end, as shown in Fig. 1.

In several steamers having to make up with river water, which is always more or less dirty, and makes a lot of hand-scaling necessary, their internal pipes were altered to the plan described above, and in every case the result was the same; the boilers in a few months becoming uniformly clean everywhere, and all the loose dirt being found heaped up at the back end of the bottom of the shell.

Of course an internal feed pipe is no novelty, most steamers now have them, but its arrangement is deserving of a little more study than is usually bestowed upon it. In the previous examples, each pipe as originally fitted was discharging, so that the circulation was checked instead of assisted, and when the boilers were emptied a lot of hard scaling was always done, but after fitting the pipe as shown in Fig. 1, hardly more than a brushing out was required. I think the best place for the cross-pipe is a little less than half the length of tubes from the front end.

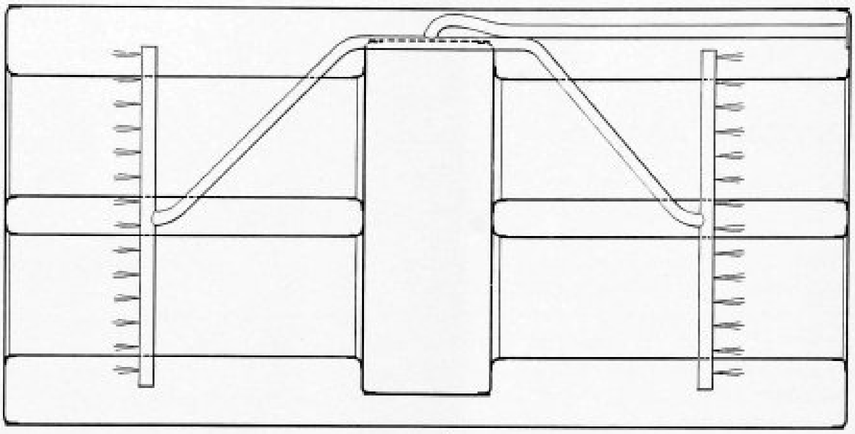


FIG. 2.

For a double-ended boiler, something like the arrangement shown in Fig. 2 would be suitable; and it will be found that the result obtained will fully repay the expense of fitting. It is necessary to see that plenty of well-fitting hangers are used to support the pipes. DRAZIT.

New Zealand.

LAYOUT OF A Y-BREECHING.

BY JOHN COOK.

The layout about to be described is one which the author has never seen in any trade journal or text book, but as he has made many of them he considers that the plans are of sufficient importance for publication.

Fig. 1 shows the elevation and Fig. 2 the half plan. First draw the base line *A B*; then erect the perpendicular line *C D*, and with *C* as a center lay off along the line *A B* the points *M* and *N* half the distance between the center lines of the two boilers. Then using *M* and *N* as centers, lay off the points *J J* and *H H*, making the distances *J J* and *H H* equal to the length of the opening of the up-take. Drop lines from these points at right angles to the line *A B*, and lay off the half plan as shown. In the half plan *J' J"* and *H' H"* represent half the width of the rectangular opening.

Extend the line *C D* until it cuts the center line of the plan, and draw the half circle showing the connection with the stack. Divide this semi-circle into any number of equal parts; in this case eight have been used. Lay the straight edge on points 2 and 8 of the semi-circle, and draw lines cutting the center line as shown at *c*. Do the same with points 3 and 7 and 4 and 6, and mark these points as shown, 5, *a*, *b*, *c* and *d*.

The height of the breeching is generally given on the blue print. Lay off this distance on the center line *C D*, Fig. 1, and draw horizontal line 1-9, cutting *C D* at point 5. Then with 5 as a center draw the half circle and divide it into the same number of equal spaces as were used in the half plan. It is not necessary to draw this semi-circle, as the points can be projected from the half plan to the line 1-9 in the elevation. It is the author's practice to locate the point *d* about half the height of the breeching. The outline of the connection can then be completed, drawing lines *d J*, *d H*, 1-*J* and 9-*H*.

It is next necessary to draw the curved line which represents the intersection of the two legs of the connection. This curved line is not an arbitrary one, and it can be drawn in to please the eye. Having drawn it, however, divide it into the same number of equal spaces as were used in the quarter plan of the stack. Then lay the square on the line *C D*, and square off these points to the line *C D*, as shown.

Now draw a base line *S G*, Fig. 4, and erect the perpendicular line *S* 5. Get a piece of lath or hoop iron and lay it on the line *C D*, Fig. 1, marking on it the points *C*, *d*, *c*, *b*, *a* and 5. Place this on the line *S* 5, Fig. 4, with the point *C* resting on point *S*. Then mark the points on the vertical line, as shown, at *d*, *c*, *b*, *a* and 5. Now set the trams from the points *H'* to 5 in the plan, Fig. 2, and with *S*, Fig. 4, as a center lay off this distance along the line *S G*, locating the point 5. Proceed in the same manner to locate *a*, *b*, *c* and *d*.

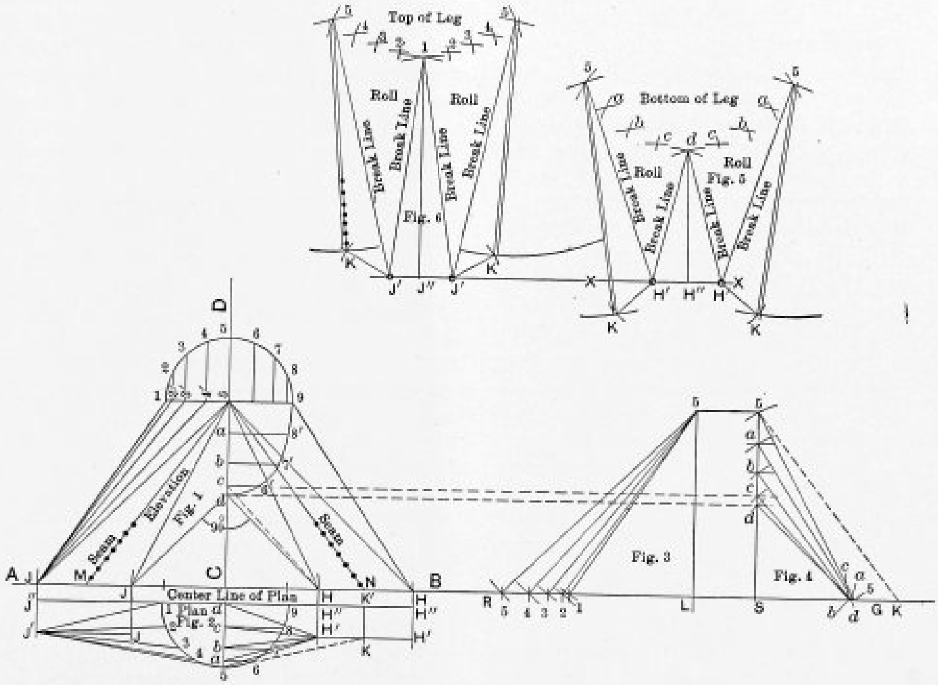
Next divide the half plan of the rectangular opening, Fig. 2, into the two equal parts, as shown, by the line *K K'*. Then set the trams the distance 5 *K* on the plan, and lay this distance out on the line *S C*, Fig. 4. This gives the true lengths of all the lines forming the lower half of one of the legs of the Y connection.

To get the development for this part of the connection draw the base line *X X*, Fig. 5, and lay off on this the width of the rectangle, as shown, at *H' H'*. Then set the trams from the point *d* on line *S G*, Fig. 4, to point *d* on line *S* 5, Fig. 4, and with points *H'*, Fig. 5, as centers strike arcs intersecting at point *d*, Fig. 5. In a similar manner locate the other points *c*, *b*, *a* and 5 in Fig. 5, using the dividers set to the equal spaces on the curved line, representing the intersection of the two legs in Fig. 1. Care must be taken to set the trams on the right marks on lines *S G* and *S* 5, Fig. 4, in order to make an accurate development. Points *K* in Fig. 5 are located by setting the trams from 5 to *K*, Fig. 4, and using 5, Fig. 5, as a center, then striking arcs of indefinite lengths, after which, using points *H'* as centers, with dividers set to the distance *H' K*, Fig. 2, intersect the arcs previously drawn at points *K*.

The lines 5 *K*, Fig. 5, are the center lines for rivets, while lines *H' K* are cutting lines. The lines 5 *H'* and *D H'* are break lines, and this should be indicated on the layout. The curved line 5 *d* 5 is also a rivet line.

To develop the top part of the connection draw the base line *R L*, Fig. 3, and erect the perpendicular line *L* 5 equal to the height of the connection. Then with the trams set from the points *J'* to the different numbers on the quarter circle, Fig. 2, and using *L* as a center, lay off the various distances on the line *L R*. The lines drawn from point 5 on the vertical line to these various points on the horizontal lines will be the true length of lines for the upper section of the connection.

The plate can then be laid out, as shown in Fig. 6, in a manner similar to that described for Fig. 5, *J' J'* being used as a base line.



LAYOUT OF A Y-BREECHING.

DANGEROUS OXY-ACETYLENE APPARATUS.

When oxy-acetylene welding apparatus was first placed on the market it was only natural for boiler makers to look upon the handling of such apparatus as a more or less dangerous job. Disastrous explosions had been known to occur where oxygen and acetylene gases had been used for various industrial purposes, and it was felt that unless the apparatus was thoroughly perfected and safe-guarded the same danger might exist with the various welding devices. In view of this natural feeling undoubtedly our readers will be interested in the following communication published in a recent issue of *Machinery:*

Believing that you are desirous of informing your readers correctly, concerning the bad practices which are resulting disastrously to the oxy-acetylene industry, you are requested to publish the following communication. Realizing that some of your readers may possibly consider that the statements were inspired by a selfish interest, we invite a most searching investigation as to their correctness:

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dangerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself cannot be ignited without a mixture of air or oxygen unless it is compressed to more than 30 pounds pressure.

Chemically, oxygen is made from chlorate of potash and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene nor the chemicals are at all dangerous if they are properly handled; improperly treated they can be made exceedingly dangerous, just as can ordinary coal or water gas, or any of the hydro-carbons, such as gasoline or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry that they are the subject of yearly inspection by a body of engineers in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character. Generators built in accordance with these rules can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond question that what is known as the carbide-to-water types are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat," which is similar to the heat of lime when slaking, only the heat is much greater. One pound of carbide will boil 6 pounds of water; consequently, the engineers for the insurance underwriters have a rule requiring 1 gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water cam into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with rapid generation there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators in the earlier part of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene that when it is compressed to from 30 to 45 pounds or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience there are persons who are manufacturing acetylene by compressing it direct from carbide without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting and passed resolutions condemning this process, which is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire and an explosion follow. Obvious as is this danger there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly no intelligent insurance representative would approve of such apparatus.

So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use. It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer and the most expensive part of the plant—the compressor. Such a plant could be built at small cost and at considerable profit. That this is being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals have the compressors built with two stages of compression, with an inter-cooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites can be and are sold for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results and tend to discredit the process. Such apparatus has injured the art not only in this country but in Europe as well. Solicitations have been received by the company which the writer represents to sell its apparatus in Austria by a very prominent firm, whose letter states that that country has numerous cheap and ineffective plants, which have brought the process into disrepute.

New York. AUGUSTINE DAVIS,
President, Davis-Bournonville Company.

THE DISEASES OF BOILERS.*

Boilers are heirs to nearly as many diseases as the human family. Some are crippled from birth, owing to errors in construction. The most marked and important of these congenital troubles is the one that makes itself known by the failure of the lap seam along a line which passes close to the

* From an address before the New England Association of Electric Lighting Engineers, by F. S. Allen, chief inspector of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

rivet holes, but usually does not enter them, except when radiating branch cracks are present.

There were few failures from the lap joint crack when iron plate was exclusively used in the construction of boilers, and this was doubtless due to two main facts: First, the fact that the plates then used were small, and second, the fact that steel (which is now used almost universally for boiler shells) is much more likely than iron to develop this particular defect.

Certainly the workmanship was no better in the days of iron than it is now, and in fact it was, as a rule, probably distinctly inferior; and while the pressures that were carried were less than they are to-day, the boilers were no better adapted, by reason of design and construction, to bear those lower pressures than modern boilers are to bear the higher ones that we find to-day.

A more important circumstance was, that in the use of iron it was impossible to obtain large plates. Thus boilers 4 feet or more in diameter were made with two plates to a course, and a boiler 16 feet long was usually built in five courses, and never in less than four. The girth seams doubtless stiffened the plates, for in the examination of a great number of boilers that had exploded by rupture of the seams it was found that the fractures commenced midway between the girth joints. In hundreds of cases, too, the main lines of fracture has developed lateral branch cracks, which have been detected by the inspector because they showed just beyond the edge of the inner lap; and then, by cutting out rivets and opening the joint, longitudinal fractures have been discovered without actual explosion of the boiler. Cracks discovered in this manner are always in the center of the course. Furthermore, in destructive tests of boilers we have found the distress to begin, and failure to occur, at the middle of the course. All of these facts show the importance of the stiffening action of the girth joints upon the shell.

Passing now to the consideration of the effect of the material itself, we note, first, that iron withstood the severe treatment of whipping down the ends of the plates with sledges—this practice having once been nearly universal in boiler shops. The only remedy for this is to provide a massive former, which, by heavy pressure, finishes the ends of the plates and brings the laps to as nearly a circular form as possible, though even with this precaution there is always some flattening at the lap.

Steel appears to resent the sledge-hammer treatment, and it is also sensitive to the slight local movements that occur near the joint, owing to variations of pressure in the boiler, and to the fact that the contour of the boiler shell is not truly circular near the joint.

These causes, singly or in combination, are very likely to cause fractures at the longitudinal joints, these being undiscoverable except by cutting the plates apart, unless branch cracks happen to radiate from the main line of fracture, and run out from the edge of the lap. Often, too, the plates are not bent in the rolls, so that they conform to each other in shape at the ends; and in this case the closing up of the joint, as the rivets are driven, causes a severe and permanent stress in the material, the effect of which is doubtless to hasten the formation of a lap joint crack.

Another defect that can be produced in riveted joints is due to neglect in adapting the pressure that is employed for closing the rivets, in hydraulic riveting (which is the best method of riveting), to the nature of the joint that is being made. The pressure that is maintained upon the accumulator should be varied according to the diameter of the rivet that is to be driven, and the thickness of the plate of which the shell is to be made.

Ruptures of plates from these causes occur with little reference to factors of safety, or to the age of the boiler. They sometimes develop within a year or two, while in other cases they do not appear until after several years of service.

Alteration of the structure of the material of the boiler, under the influence of stress and temperature, is undoubtedly the cause of failure in many cases, and evidence of the fatigue of metal, which admittedly occurs in all classes of machinery, is found in boiler plates. Fractures in the plates, away from the seams, have been found occasionally, and surface cracks, either internal or external, may develop in the shell, the plates being then brittle enough to be readily broken up with a hammer when they have been removed from the boiler. Such cracks are not so frequent, in the central or free parts of the plate, as they are near a flange or some other rigid connection, where the effect of the movement of the plate may be localized. The localization of strains in this way has been the cause of frequent failure or fracture in some types of boilers, with the result that expensive repairs have been required, and in many cases explosions have resulted.

We also find evidence of profound alteration of the structure of the material in boiler tubes, these often losing their ductility after a few years of service, even though they may have been reasonably ductile when new. Undoubtedly the skelp from which these tubes were made was of an inferior quality and the alteration in their structure, with the resulting liability of fracture, is probably due to the temperature to which they are exposed, rather than to the pressure.

There is much difficulty in detecting alteration in the structure of a boiler tube, although there is not infrequently some unusual color to the tube, or some unusual sound given out under the hammer test, that will attract the attention of the examiner. A case which came under my own observation related to a large battery of boilers in which the tubes showed no evidence of thinning, overheating, distortion, or sediment. They were found to have the full standard thickness required for boiler tubes of their diameter. When they were rubbed clean of soot and ash, down to the original skin of the metal, however, they showed a peculiar and unusual color, although under the file bright metal showed at once. The appearance of the tubes was so peculiar that two of them were removed for testing, with the result that they were found to have lost their ductility almost entirely. The tubes in all the boilers were subsequently removed, and all (or nearly all) were found to be brittle, often breaking when one or two blows were struck upon the chisel in cutting them off. For the sake of comparison, a tube that had been in service in another boiler in the same plant for 23 years was removed, and the physical tests that were made upon it showed that its condition was excellent. In this case, however, the tube had not been subjected to a temperature in excess of that due to 125 pounds of steam pressure, while the boiler having the defective tubes had been operated at 160 pounds pressure. The old tube, moreover, which was in good condition after many years of service, was made of charcoal iron, while the others, which had become brittle, were of steel.

Of late there are many defective bolts found among those that are used for holding the tube caps on the manifolds in some types of watertube boilers. This is a dangerous defect, as most of these boilers are operated under high pressure, and the caps are upon the outside, so that the failure of the bolt releases the whole contents of the boiler into the fire room. This matter is so serious that it has been taken up by one of the large electric road operators, and chemical tests have been made of the various bolts in actual use, and of the bolts purchased. The number of defective bolts found during the past year was very great, while ten years ago it was the exception to find any such bolt defective. I cannot say what the result of the investigations now going on in my department, and among steam users, will develop, but from personal investigation I believe that the bolts that have been used for the past few years are of steel, and evidently they are commercially-made bolts. The ductility of many of the defective bolts is so far reduced that, though they are an inch in diameter, a blow from the light hammer used by the inspector would snap them off with a single blow. Many were also found to be cracked partially through.

With regard to these bolts I would say that the remedy, in my opinion, would be to use bolts that are forged from the very best quality of Swedish iron. These bolts are not subject to alternating or intermittent variations of stress, and hence it appears probable that the change in molecular structure that they undergo is to be ascribed to the natures of the material from which they are made, the alteration taking place as a result of the temperature to which they are exposed.

One other cause of rapid deterioration and loss of efficiency in boilers is the formation of incrustation and scale. Watertube boilers are peculiarly sensitive to this, as their tubes are liable to become overheated, and the thin material of which they are made then becomes subject to distortion, where the relatively heavy plates of a boiler shell would remain comparatively unaffected. A great many cases of this kind occur yearly, and the rupture of the tubes is not infrequent.

Some twelve years ago several tubes ruptured in one of our best equipped and largest electric plants, and overheating of the lower tubes was noted in all the boilers. Many were quite badly affected, and others not so seriously. Some of the least affected tubes were selected, and many specimens taken from them were sent to Watertown, Mass., for test. The results were of considerable value. Test pieces were taken from different parts of the same tube, and on two tubes, specimens taken from the top of the tube, over the furnace, gave an elongation in a length of 8 inches of 18 and 19 percent, respectively, the ultimate strength of the material being 57,800 and 58,000 pounds per square inch, and the elastic limit 28,900 and 39,000. Specimens taken from the same tubes in the rear of the bridge wall and on the upper side, where they were exposed to the descending currents of heat, but not quite at the exact topmast point, gave elongations of 16 and 17 percent, respectively, in a length of 8 inches, the corresponding tensile strengths being 55,700 pounds and 58,000 pounds, and the elastic limits 36,300 pounds and 38,000 pounds. These were the best tests, some of the others running somewhat lower for strips taken in similar localities. Test pieces taken from the bottom of a tube over the furnace, but in locations selected so as to avoid distorted spots, and to secure specimens that were apparently uninjured, gave ultimate strengths running from 41,500 pounds to 46,500 pounds per square inch, the elastic limit in these cases ranging from 24,000 to 31,000 pounds per square inch, and the elongation in a length of 8 inches from 2 to 9 percent. Another set of tests gave results better than those just quoted, but in these cases the specimens were taken from the side of the tube, just above the center; the tensile strength running in these instances as high as 47,000 pounds per square inch, and the elongation as high as 12 percent in a length of 8 inches.

The tests made upon specimens taken from the top of the tubes in the upper part of the boiler, where there was no direct exposure to the fire, showed a total strength and a percentage of elongation that were practically the same as the corresponding results for new tubes, although the boilers had seen some two years of service. The rapid deterioration of the tubes was considered to be largely due to the feed-water and to the nature of the incrustation. A change was made in the water supply, and I do not recall any trouble with tubes that has been experienced at this plant since.

The failure of tubes in watertube boilers is not infrequent. It is sometimes due to defects in construction or in welding; but I have noted one peculiar fact, which has impressed me considerably, and that is, that except in cases in which the weld was defective, I have not noted a single case in which the failure occurred directly at the bottom of a tube. This fact may be of little interest, but it has impressed upon my mind the view that structural change in the material leading to the failure or splitting of the tube takes place a little towards one side of the bottom, or (say) at "about 8 o'clock" in the circle of the tube.

The increase of temperature attendant upon the use of higher pressures has brought about some new developments detrimental to boilers in connection with the formation of scale, and this is especially true in the fire-box type of upright boilers. There is little space in these boilers for the deposit of scale upon the tube sheets directly over the fire, and in view of the large amount of heating surface and the normal evaporation the formation of scale must be very rapid upon the tube sheet, especially when the feed water is at all brackish. Two marked instances are worthy of notice, the observed results seeming hardly credible. In both cases the boilers were nearly new and were of good construction, and working under proper factors of safety. Leakage around the tubes developed quite early. In one of the cases the trouble occurred in a battery of very large boilers of this upright type, operating at a pressure of 170 pounds per square inch; the owners in this case (as well as in the second one, presently to be noted) having a large number of boilers of the same type operating at 125 pounds. There had never been trouble from scale, although in the older boilers operated at 125 pounds there was a considerable deposit of mud, which was readily removed by periodical washings. No trouble from leakage had been experienced from this sediment at any time, in any of the boilers of this plant, until the new high-pressure boilers were installed for electric power; and the plant was thoroughly modern and up to date, and everything of the best construction. An examination of the high-pressure boilers, after the leakage around the tube ends had developed, showed a thin, hard coating of sulphate of lime over the whole tube sheet and making a slight fillet around each tube. The coating resembled an enamel lining more than a scale, owing to its extreme thinness and its adherence to the plate. The fact that the same water had been used in boilers in operation in this plant for over twenty years, and that no trouble had occurred from scale or deposit, made it difficult to persuade the engineer that the leakage was due to the feed water, and to scale formation; but by the judicious use of solvents the enamel-like coating was finally dissolved, and no leakage has occurred since, solvents being now used to prevent further deposition of scale. The second case was similar to the first, but the plant was many miles away and used an entirely different water. Nevertheless the same kind of action took place in the boilers that were operated at 160 pounds, although boilers in the same room had been operated on the same water with entire success for twelve years at 125 pounds. This second case also yielded to treatment, and the affected boilers have since been running at their maximum capacity without leakage or trouble of any kind.

By way of explanation we may assume that the difference between the temperature due to 125 pounds pressure, and that due to 160 pounds, was sufficient to cause the precipitation in each case of a small quantity of sulphate of lime, which, at the lower temperature, had remained either in solution, or in suspension with the mud that had been washed out so readily.

The importance of eliminating all lubricating oils from boilers is almost too well known to be worthy of mention, yet oil continues to be a great source of injury and destruction, where the water of condensation is recovered from the exhaust steam and used over again in the boilers. Separators are put in, having a nominal capacity based upon the area of the exhaust pipes, without reference to the volume of steam that these exhaust pipes are to carry. This is a grave error in many cases. Separators have capacity as well as other machinery; and in installing an oil separator, care should be taken to ensure for it a capacity to handle the full volume of steam passing through it.

There also seems to be much difficulty experienced in removing oil from boilers when it has once effected an entrance. This can be done readily in some types of boilers by swabbing the sheets and tubes with a mop dipped in kerosene oil after taking the highly important precaution of *extinguishing all open lights* about the boiler as a measure of safety. In other cases, where the boilers are inaccessible for mopping, they can be boiled out with a strong solution of soda ash (or caustic soda if the soda ash does not prove effective), with a generous addition of kerosene oil, the pressure being maintained at half or two-thirds of the regular working pressure for from 12 to 20 hours. After this treatment the oil can usually be washed out in the form of a curd.

Corrosion, another boiler disease, is not so common to-day as formerly, but it still is an active enemy of steam boilers. I say it is less common than it was formerly, because a great change has been made in the last few years in the types of boiler in general use, and those that are at present most common are less liable to corrosive action than were the drop flue, hammer head, and similar types having a poor circulation at the bottom. We still have with us some types in which there is a tendency to corrosion, and no universal remedy can be relied upon. Instead, each case must be carefully investigated and a remedy applied that is appropriate to the cause of the difficulty. Where the water is pure and the boilers are operated intermittently, corrosion is frequently found in the form of pitting. This action takes place very often in pumping stations and in power plants and electric stations where the fires are kept banked for long periods, with the water in the boilers quiescent, and far less often in boilers that are always in active service. Boilers that are used exclusively for heating purposes suffer more than any others from pitting.

Once started, corrosion is likely to go on until the material of the boiler is destroyed, unless measures are taken to check it. When corrosion is observed in connection with the use of a pure water, one of the best methods of treatment is to keep the water alkaline with soda ash, for this tends to check the corrosive action and the soda does not injure the boiler.

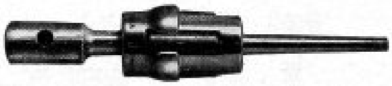
Care should be exercised in selecting feed water for a new plant, or for a new location of a plant, to see that the quality of the water is good. Nitrates in the water should be especially avoided, as they are especially troublesome and dangerous. The presence of nitrates commonly results in the formation of a light scale coating, under which an active destruction of the material of the boiler goes on, the plates and tubes becoming wasted away and the braces and rivet heads cut off.

In certain types of boilers the breakage of stay-bolts is a frequent and annoying, as well as expensive, occurrence. Such bolts are often drilled with a 3-16 inch hole, which either passes through the entire length of the bolt, or at least goes in deeper than the thickness of the outside sheet, and such holes are supposed to give absolute safety, so far as the detection of broken bolts is concerned, the theory being that steam will escape from the end of the bolt as soon as fracture has occurred, and thereby call attention to the trouble. The drilled hole is not to be relied upon, however, because, in the process by which the stay-bolt fails, the fracture will creep into the bolt slowly, and when it first encounters the hole, moisture from the boiler will leak out through it in very slight quantities and evaporate without attracting any attention. In evaporating, however, the moisture leaves behind it a certain amount of solid matter, and this accumulates until it forms a hard, baked residue, completely choking the opening in the center of the bolt, so that the apparent absence of leakage leads to a sense of security, which is far from corresponding to the actual facts. Many bolts that have been drilled for the purpose of providing security against undiscovered fracture have been found to be completely broken off, and many others have been found to be partially broken without any noticeable leakage occurring in either case. It will be plain, therefore, that if any reliance is to be placed upon the drilled stay-bolt, it is important to ream out the holes frequently and keep the openings free. The breakage of stay-bolts is sometimes due to circumstances connected with the environment of the boilers, to their exposure to injury from external causes, to strains from varying temperature and differential expansion, and to faulty construction or poor material in the bolt.

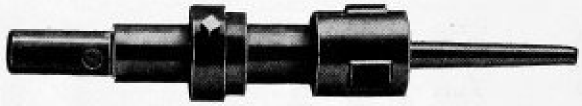
Many of the minor diseases of boilers, such as rapid loss of ductility, and development of incipient fractures at different parts (as at the girth joints in the plain tubular boiler), may be due to the conditions under which the boilers are operated, such as to the varying level of the water, and to the introduction of cold feed water, or to blowing down the boilers under high pressure and leaving the drafts on, so that cold air may be drawn through and so give rise to serious unequal contraction, or to pushing the fires too hard in raising steam from cold water. Severe strains, resulting in leakage at the seams and around the stay-bolts and tube ends of fire-box boilers, are frequently caused by the burning out of the fire under one boiler of a battery, while this boiler is left connected with the rest of the battery and with the draft full on. All these defects are developed by poor practice or management.

Just a word, in conclusion, about the action of superheated steam. When superheating is done in connection with steam generators, the elasticity and strength of the material are affected if a high temperature is produced, and I look forward with considerable anxiety to the results that may follow when boilers are operated in this way for a term of years. It has been brought to your knowledge, I believe, or to the knowledge of similar bodies, and it has come under my own observation, that cast iron is an unsuitable material to use for exposure to superheated steam of high temperature. I have in mind some extra heavy valves of the best make, with cast iron bodies, which, when exposed to superheated steam at high temperature, became badly checked and marked, so that the whole body of the casting had an appearance suggestive of the crazy cracking observed on imperfect crockery. These valves were replaced by others in which soft steel castings of the best quality were used in the place of the cast iron, and the new ones have thus far, I believe, shown no defects. Fittings or manifolds of cast iron connecting superheaters with the generator should not be endorsed or approved for superheating to 100 degrees or over. In fact I think that cast iron for such purposes has already been abandoned in the best practice, forged or wrought iron being substituted for it.

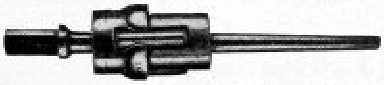
From tests made at the Watertown Arsenal, in order to determine the strength of steel at different temperatures, it is noted that at 400 degrees F. a test bar showed a tensile strength of 75 tons per square inch, whereas at 1,600 degrees F. the tensile strength was reduced to about 10 tons.



"Boss" Roller Expander (Hand Use)

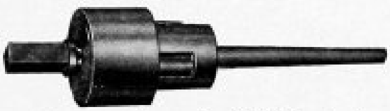


Arch Flue Expander



"Boss" Roller Expander (Self-Feeder)

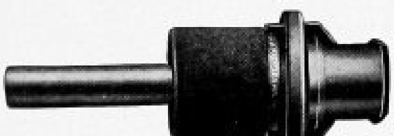
Universal Expander (Hand Use)



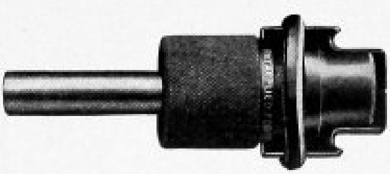
Universal Expander (Self-Feeder)

Removable Collar Expander (Hand Use)

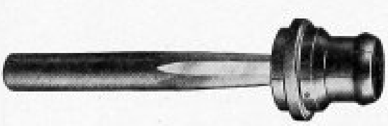
Removable Collar Expander (Self-Feeder)



Rapid Beading Expander



Rapid Beader Tool



Improved Sectional Expander

FAESSLER

BOILER MAKERS' TOOLS

Roller Flue Expanders

All made with double-length reversible rollers, practically doubling the life of the tool. For hand or air motor use.

"Boss" Expander. Strongest and most durable or tool of its kind, and has fewest parts.

Universal Expander. For flues cut longer than necessary. Takes any length up to 1¾ in. projection.

Removable Collar Expander. Rolls any flue that projects 1 in. or less. The tool's steel collar prevents wear from contact with end of the flue.

Arch Flue Expander

Adjustable to arch flue in any locomotive boiler, no matter how far apart the sheets may be. Makes a tight flue every time. For hand or air motor use.

Sectional Beading Expander

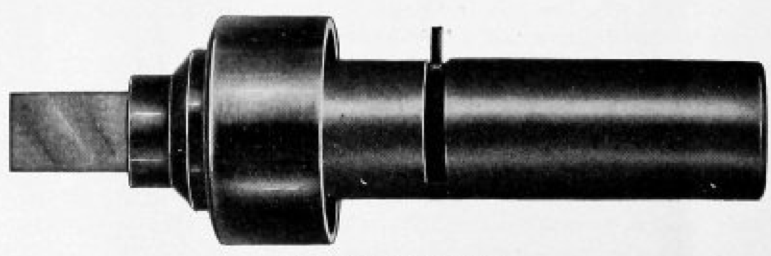
The octagonally-tapered mandrel gives strength and durability by providing a full bearing for each section. The mandrel also stays in place better than a round one, and hence is less liable to injure the operator. Furnished with steel spring or rubber binder.

Rapid Beading Expander

Prossers a flue in 10 seconds, and does it right. Used in connection with an air hammer. The light blows are easy on the flue sheets.

Perfect Flue Cutter

May be used with or without motor. Requires only one man to operate. Simplest and fastest cutter made.



"Perfect" Flue Cutter

INSPECTION RECORDS.

BY C. E. LESTER.

One does not greatly appreciate the importance of complete records until he is called upon to furnish some record he is supposed to have and finds that he cannot produce it. I recall very well a time when I was holding my first position of foreman boiler maker that the company with which I was connected had rented several locomotives from another company. The master mechanic's office did not keep a record of front end inspections, and the foreman boiler maker was called to do this, and I did keep a fairly good record for about a year.

* Form 2750-B. 20-8. '09—1000

ERIE RAILROAD COMPANY.
NEW YORK, SUSQUEHANNA & WESTERN RAILROAD COMPANY.
NEW JERSEY & NEW YORK RAILROAD COMPANY.
CHICAGO & ERIE RAILROAD COMPANY.

MECHANICAL DEPARTMENT.

Report of Condition of Fire-Box and Inspection of Staybolts.

STATION__________ DATE__________ 190__

Flues__________

Flue Sheet, Back__________

Smoke Arch__________

Crown Sheet__________

Crown Bolts__________

Side Sheet, Right__________

Side Sheet, Left__________

Door Sheet__________

Mud Ring__________

No. Staybolts Broken__________ No. Renewed__________

Are Staybolts Drilled Outside?__________

Are Detector Holes Open?__________

Estimated Life of Fire-Box, in Months__________

I HEREBY CERTIFY that I have examined the Fire-Box, Flues and Staybolts of Engine No. __________ and find condition as above.

*Signed*__________ INSPECTOR.

*Correct*__________ FOREMAN BOILERMAKER.

*Approved*__________

FIG. 1.—FORM 2,750.

The locomotives had been returned to the company to which they belonged, and I decided that the front end inspection records were of no more use and destroyed them. The next week I was requested to produce them. "'Nuff ced."

Different railroad companies have different methods of keeping records of the inspection of boilers and their appurtenances, but for general information and simplicity the accompanying forms in use on the Erie Railroad are, I believe, equal to any I have seen.

Form 44-B (Fig. 2) is a combination certificate of boiler inspection and is used for either stationary or locomotive boilers. The card (6 inches by 8 inches) is framed and posted conspicuously in the cab of the locomotive or on the wall of the boiler room, and is used simply as a source of information to the shop force and engine crews to denote that an inspection and test guarantees that the boiler is safe to carry the recorded working pressure.

Form 2,750 (Figs. 1 and 5), as noted on the reverse side of the card, is required to be furnished monthly by the local

F Form 44 B 10, 1907—5m

ERIE RAILROAD COMPANY.
CHICAGO & ERIE R. R. CO. NEW JERSEY & NEW YORK R. R. CO.
NEW YORK, SUSQUEHANNA & WESTERN R. R. CO.

CERTIFICATE OF BOILER INSPECTION.

__________*Shop,*__________ *190*

I hereby certify that I have made a careful external and internal examination of $\frac{\textit{Locomotive}}{\textit{Stationary}}$ *Boiler No.*__________, *and tested same with a hydraulic pressure of*__________*lbs. and a steam pressure of*__________*lbs., and find it in gooa condition and safe to carry*__________*lbs. working pressur*e. *The jacket* $\frac{\textit{was}}{\textit{was not}}$ *removed at this examination.*

__________*Inspector.*

__________*Division.*

Approved:

__________*Master Mechanic.*

FIG. 2.

+ Form [illegible] ENGINE No.__________

ERIE RAILROAD COMPANY.
NEW YORK, SUSQUEHANNA & WESTERN R. R. CO. NEW JERSEY & NEW YORK R. R. CO.
CHICAGO & ERIE R. R. CO.

MECHANICAL DEPARTMENT.

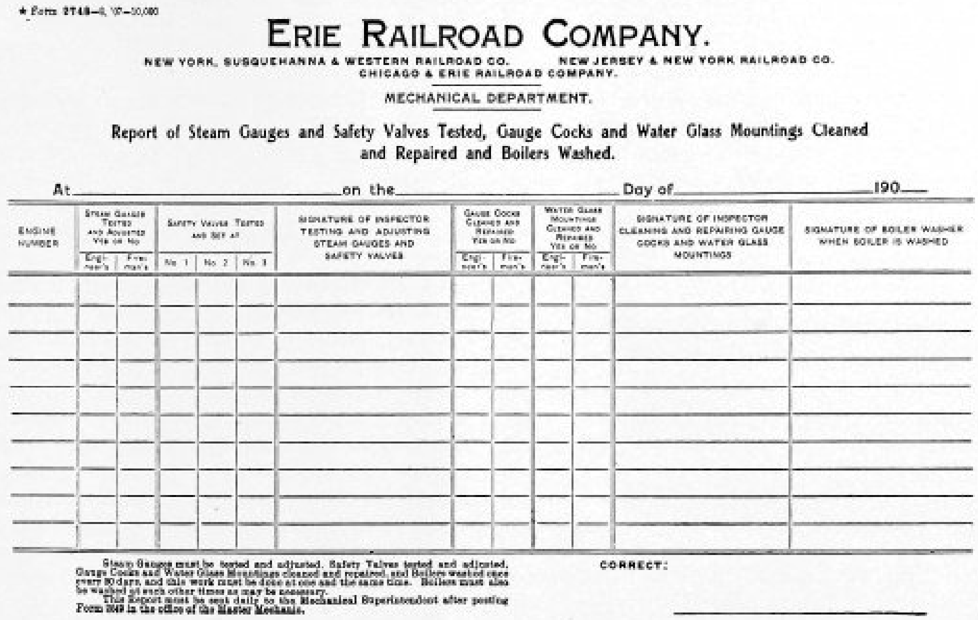
Record of Staybolt Inspection, Steam Gauge and Safety Valve Test, Gauge Cocks and Water Glass Mountings Cleaned and Repaired and Boiler Washing.

DATE		STATION	STAYBOLTS INSPECTED		STEAM GAUGE TESTED		SAFETY VALVES TESTED AND SET AT			GAUGE COCKS CLEANED AND REPAIRED		WATER GLASS MOUNTINGS CLEANED AND REPAIRED		BOILER WASHED		
Month	Day			No. Renewed	Engineer's	Fireman's	No. 1	No. 2	No. 3	Engineer's	Fireman's	Engineer's	Fireman's	Date	Date	Date
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

[illegible]

FIG. 3.

boiler inspector. It is, of course, desirable to know for what reason stay-bolts are renewed, and for this reason the symbols in the upper right-hand corner were adopted. There is an individual form for every class of locomotive on the system, and the diagram on the reverse side of the card shows the shape of the sheets and the exact location and number of every stay-bolt



★ Form 2748—6, '07—10,000

ERIE RAILROAD COMPANY.

NEW YORK, SUSQUEHANNA & WESTERN RAILROAD CO. NEW JERSEY & NEW YORK RAILROAD CO.
CHICAGO & ERIE RAILROAD COMPANY.

MECHANICAL DEPARTMENT.

Report of Steam Gauges and Safety Valves Tested, Gauge Cocks and Water Glass Mountings Cleaned and Repaired and Boilers Washed.

At __________ on the __________ Day of __________ 190__

Engine Number	Steam Gauges Tested and Adjusted Yes or No		Safety Valves Tested and Set at			Signature of Inspector Testing and Adjusting Steam Gauges and Safety Valves	Gauge Cocks Cleaned and Repaired Yes or No		Water Glass Mountings Cleaned and Repaired Yes or No		Signature of Inspector Cleaning and Repairing Gauge Cocks and Water Glass Mountings	Signature of Boiler Washer When Boiler is Washed
	Engi-neer's	Fire-man's	No. 1	No. 2	No. 3		Engi-neer's	Fire-man's	Engi-neer's	Fire-man's		

Steam Gauges must be tested and adjusted, Safety Valves tested and adjusted, Gauge Cocks and Water Glass Mountings cleaned and repaired, and Boilers washed once every 30 days, and this work must be done at one and the same time. Boilers must also be washed at such other times as may be necessary.

This Report must be sent daily to the Mechanical Superintendent after posting Form 2649 in the office of the Master Mechanic.

CORRECT: __________

FIG. 4.

and radial stay in the fire-box. The inspection is required to locate every patch, crack, etc., on the diagram. Repairs made simultaneously with inspection are noted in red ink. The condition of the several parts, as well as the approximate life of the fire-box, are required to be shown on the face of the form.

Form 2,748 (Fig. 4), covering boiler washing, inspection and repairs to boiler mountings, is required to be signed by the several men performing the different work and certified by the man in charge.

Forms 2,750 and 2,748 are required to be furnished at least every thirty days and simultaneously. From 2,649 (Fig. 3) is an office record kept by master mechanics and the general mechanical superintendent. It will be noted that this form gives a complete record of dates of required information, and gives a summary of individual engines.

Forms 2,748 and 2,750 pass through the offices of the master mechanics, general foreman boiler maker and general mechanical superintendent; each office keeps registered by engine number and filed by date in a cabinet file in the office of the general mechanical superintendent.

This gives a complete check on all locomotives, and it is practically impossible for an engine to run over the inspection period without being caught within a very few days.

Tapping Stay Bolt Holes in a Marine Boiler.

We had some work on a marine boiler which included the tapping of the inner and outer sheets for staybolts. The sheets were 10 inches apart. The tap was 1⅝ inches diameter, 18 inches long, and was fluted the full length.

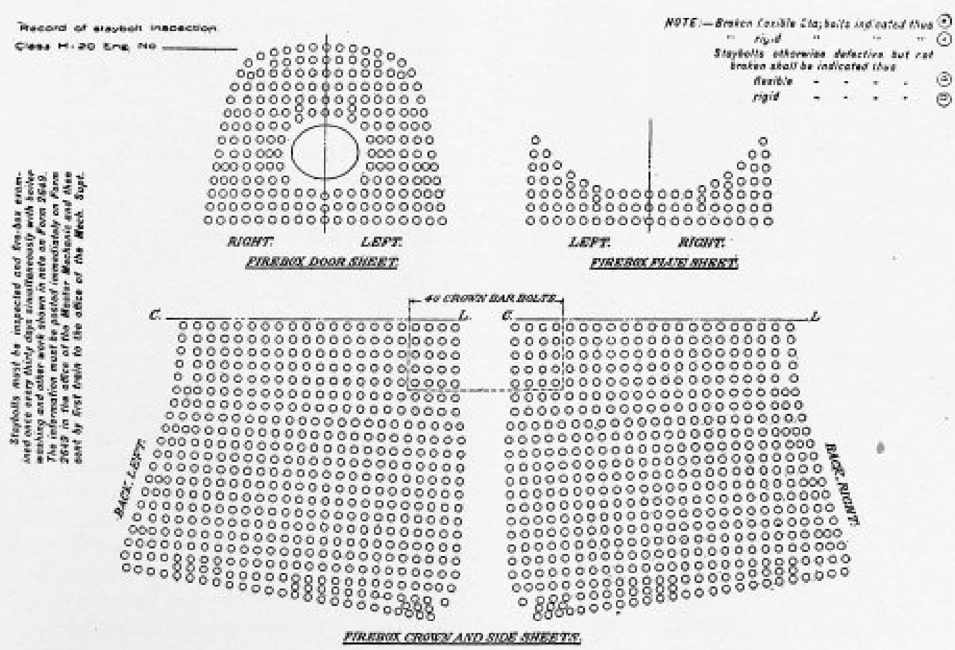


FIG. 5.—REVERSE SIDE OF FORM 2,750.

It was used in an air machine, but we found that after it started to cut the inside sheet it still kept cutting the outside one. So much so in fact that the staybolts would almost drop in place. We then made a new tap, but fluted it for only 9 inches from the end. The front end we fitted with a tit or guide 10 inches long and the size of the drilled hole. After tapping the outside plate and entering the end of the tap in the inside one the part of the tap which was in the inside plate was without flutes, so it could not cut large.—*American Machinist.*

SMOKE ABATEMENT ACT FOR BOSTON.

There has been submitted by the fuel-supply committee of the Boston Chamber of Commerce a "Proposed Act for the Abatement of the Smoke Nuisance in the City of Boston and Vicinity."

The territory over which the proposed act shall be effective consists of Boston harbor, the cities of Boston, Cambridge, Somerville, Everett and Chelsea, and the town of Brookline.

The act provides for the creation of "The Metropolitan Board for the Abatement of Smoke"; classifies chimneys; outlines the manner in which the density of smoke is to be established and prescribes the degrees of smoke which shall be prohibited from issuing from chimneys of the different classes.

The smoke board is to consist of the chairman of the Massachusetts State Board of Health, ex officio, and four other members to be appointed by the Governor, with the advice and consent of the Council, to serve a term of four years each. The first appointments, however, are to be for one, two, three and four years, respectively, so that there will be retired each year only one member of the board. One member of the board is to be a merchant or manufacturer, one a lawyer, one an engineer, and one a representative of the Public Service Commission.

The board is to appoint a secretary and a chief smoke inspector and as many deputies and assistants as may appear necessary. The salary of the secretary is to be $2,500 and that of chief smoke inspector $3,600 per year. Other salaries are to be fixed by the board. The members of the board are to receive no salary, but any personal expenses which they may incur while engaged in official duty are to be repaid by the State.

The duties of the board are to enforce the provisions of the smoke-abatement act; to investigate complaints of violations of the act; to order the observance on the part of persons or corporations of the provisions of the act and to enforce such orders by legal proceedings.

Chimneys are classified by the act as follows:

Class 1 includes all fixed or stationary stacks having an inside area at the top not exceeding the area of a circle 5 feet in diameter.

Class 2 includes all fixed or stationary stacks having an inside area at the top greater than the area of a circle 5 feet in diameter but not exceeding the area of a circle 10 feet in diameter.

Class 3 includes all fixed or stationary stacks having an inside area at the top greater than the area of a circle 10 feet in diameter.

Class 4 includes all stacks of vessels having an inside area at the top not exceeding the area of a circle 4 feet in diameter.

Class 5 includes all stacks of vessels having an inside area at the top greater than the area of a circle 4 feet in diameter.

Class 6 includes all stacks on steam locomotives.

The density of smoke issuing from a chimney is to be estimated by means of the Ringelmann charts which are used by the United States Geological Survey. In the table is given the number of the smoke chart which corresponds in appearance to the most dense smoke which, under the act, may be emitted from the chimneys of the various classes, together with the lengths of time for which such emissions are permitted to continue.

It is proposed to have the act take effect on June 1, 1910.

State Boiler Inspection Department for Ohio.

A bill to provide for the better protection of life and property against injury or damage resulting from the operation of steam boilers is under consideration in Ohio. This bill is backed by the representative operating engineers of the State, a copy of it having been sent to each of the State N. A. S. E. associations; all but two, it is said, indorse it unqualifiedly.

The bill provides that the department be placed in charge of the chief examiner of steam engineers, which latter official is to receive $1,800 a year in addition to the salary now allowed him by law for acting in this dual capacity. The bill provides, furthermore, that he shall have two assistant chief inspectors at a salary of $2,400 per annum each, a chief clerk at $1,800, and such other inspectors of boilers at $1,500 each, and assistant clerks at $1,200 per annum each, as may be necessary—provided the total expenses of the department do not exceed a variable maximum provided in the bill. Necessary office and traveling expenses incurred in the discharge of their duties are allowed to each in addition to his salary.

The bill provides that all steam boilers and their appurtenances in the State of Ohio, "except boilers of railroad locomotives, boilers under the jurisdiction of the United States, and boilers in private residences, shall be thoroughly inspected

MAXIMUM DENSITY OF SMOKE AND LENGTH OF TIME FOR WHICH IT MAY BE EMITTED.

During the Year.	Class of Chimney. I		II		III		IV		V		VI		Locomotives Moving Trains of Six Cars or More.	
	Chart No.	No. Minutes During One-Hour Period.	Chart No.	No. Minutes During One-Hour Period.	Chart No.	No. Minutes During One-Hour Period.	Chart No.	No. Minutes During One-Hour Period.	Chart No.	No. Minutes During One-Hour Period.	Chart No.	No Seconds in Five-Minute Period.	Chart No.	No. Seconds in Five-Minute Period.
1910	3	6	4	5	4	10	4	9	4	12	3	40	3	50
1911	3	4	3	10	3 including 4	20 including 5	3	12	3	15	3	30	3	40
1912	2	8	3	6	2 including 3	30 including 10	3	7	3	9	3	20	3	30
1913 and subsequently	2	6	3	3	2 including 3	25 including 5	3	3	3	5	3	20	3	30

internally and externally" at least once a year. Furthermore, the hydrostatic test may be applied if deemed necessary. For this inspection service a fee of $5 is charged for each internal and $2 for each external inspection. All owners or users of such boilers must report to the chief inspector annually the location of their boilers.

It is claimed by the advocates of the bill that Ohio has become the dumping ground for condemned boilers from the State of Massachusetts, and its purpose is to stop this traffic, and also the indiscriminate selling of second-hand boilers by junk dealers, who with a fresh coat of black paint may doctor up an old condemned boiler and dispose of it to innocent purchasers. Instances of this practice are cited, and it is pointed out that Ohio, which is now generally looked up to and respected for its State license law, is too modern and progressive a community to allow such practices to continue.

Compulsory boiler inspection is the only method by which all the unsound boilers in a community can be reached and the public safeguarded, as it is, unfortunately, true that the very people who will buy without question a second-hand boiler, will, from motives of economy, refrain from having said boiler examined by a competent boiler insurance company.

The plan of exempting boilers that are insured from State inspections is pursued in Great Britain, in Massachusetts and in Connecticut, and in the cities of Omaha, St. Louis and Philadelphia. It would undoubtedly be of advantage to Ohio to follow the same plan, but legal advice on this question has brought out the fact that in Ohio this arrangement would be unconstitutional, and that every steam user would of necessity be compelled to undergo State inspection. This will increase the steam user's boiler expense per year and in just so much will it arouse his opposition.

We have not seen the decision upon which the allegation of unconstitutionality is based. The point involved is probably the inability of the State to delegate its powers to insurance companies. This is effected in Massachusetts by making the inspectors of the insurance companies virtually a part of the inspection system by requiring them to be examined by the inspection bureau and certified before their inspections will be accepted by the State. If the Ohio bill can be amended in some way so that double inspection and two fees will not be necessary, a serious objection to its passage will be obviated.

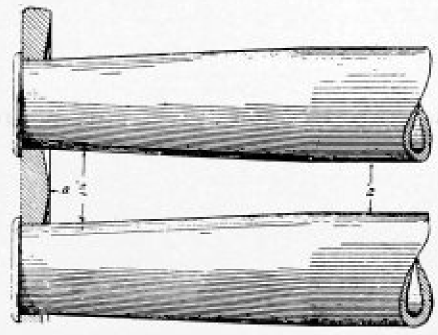
It is refreshing to learn that one of the large insurance companies of the country is working hard for the bill, and is lending its support to legislation which might readily turn to its disadvantage. Such action is to be highly commended, for only too often the reverse course is pursued.

Ohio has been a leader in the West in the matter of the license question, and the effort to establish State boiler inspection is another step in the right direction, which will be watched with interest by all engineering bodies. Other States should get in line.—*Power and the Engineer.*

Method of Flue Setting.

Our illustration shows a method of flue setting for locomotive boilers which has been devised by Mr. E. C. Stocker, a locomotive engineer on the Northwestern Pacific Railroad, and by Mr. James McAdams, foreman boiler maker on the same road. Writing of their invention, for which patent is pending, the inventors say:

"It consists in the construction of the tubes and the manner of their attachment or setting, which prevents the erosion and leakage caused by intense heat in the combustion chambers and on the tube sheets. It is accomplished by reducing the section or thickness of metal interposed between the water and fire and forming an arch at *a*, it being a well-known fact that the life and endurance of all joints in steam boilers are determined by the thickness of metal interposed between the external heat and the contained water. It also consists in swedging or reducing in diameter the end of the tubes entering the combustion chambers, and by so doing it doubles the capacity for water at that vital point and induces free circulation of water around the tubes, limiting the expansion caused



NEW METHOD OF FLUE SETTING.

by the temperature, also giving space for scale to drop from the tubes at that particular place.

"The object of reducing the tube ends at combustion chamber is to limit the rapid flow of hot gases through them, still maintaining the heating surface by the expansion of the gases as they pass from the small to the larger diameter of the tubes, which means reducing stack temperatures and cost of fuel. It also gives greater distance or pitch between the tube holes and greater stability to the tube sheets."—*Exchange.*

A SIMPLE CAMBER FORMULA.

BY THOMAS C. SCHUYLER.

In connection with boiler maker mathematics, one of the very important and frequent calculations is that made to determine the addition for camber when ordering plates for taper course work. The correct solution of the problem, according to geometrical and mathematical rules, involves much tedious work, including operations in trigonometry and extraction of square root in numbers of considerable extension. All this is very arduous, taking much time, and it is likely to be attended with errors, repetitions and corrections. In fact, it is entirely out of the realm of the quick, practical rules found to serve for all boiler work.

Several methods are in use, dispensing with operations in trigonometry but still retaining the extraction of square roots, the results being close approximations. A rule or formula involving but simple addition, subtraction, multiplication and division to the exclusion of trigonometry and square root would be of considerable advantage in this connection, providing the results obtained therefrom are perfectly reliable for practical use.

The following formula is submitted in view of the above requirements, and upon careful checking the results will be found perfectly satisfactory for all practical purposes when applied to any case of taper course conditions in straightaway boiler work:

W = Length, inches on center metal, including laps, large end.

w = Length, inches on center metal, including laps, small end.

H = Height of course, inches, including laps.

C = Camber in inches, to be added to H when ordering plates.

$$C = \frac{W(W - w)}{7.5H} \qquad \text{1}$$

In the event of the course being made in more than one plate around, the values W and w, if taken as divisions of the full circumference, including the laps, will give the chamber of the plate for the portion of circumference considered, the value of H being in all cases the same; i. e., full height of course with laps.

It will be seen upon examination of the factors that they are essential in any case as ordering sizes for the plates under consideration.

The derivation of this formula would hardly satisfy regular mathematical requirements, although it is reasonable in that it satisfies the condition of a taper course as the course approaches a cylindrical form, for if $W = x$, $w = x$ and $H = h$, then

$$C = \frac{W\,(W - w)}{7.5\,H} \qquad \ldots\ldots 2$$

$$C = \frac{x\,(x - x)}{7.5\,H} \qquad \ldots\ldots 3$$

$$C = \frac{O}{7.5\,H} \qquad \ldots\ldots 4$$

$$C = O \qquad \ldots\ldots 5$$

The factor 7.5 has been carefully selected and enables the formula to satisfactorily cover as wide a range of taper course conditions that will ever be met in ordinary work.

Laying out a Helical Surface.

In sheet metal work the problem sometimes comes up of laying out a helical surface. Such a surface is formed by two curved lines and two straight lines. The construction of the two curved or helical lines is very simple. In Fig. 1 draw two circles with the radii of the helical surface equal to $\frac{1}{2}d$ and $\frac{1}{2}D$. Now divide these circles into a number of equal parts. After having drawn the center lines in both Figs. 1 and 2, measure in Fig. 2 the pitch of the helix or screw, and divide it into the same number of parts as the circle. At each point draw a line perpendicular to the center line; also draw lines parallel to the center line, going through the points 1 to 7, Fig. 1, and cutting the parallel lines previously drawn in Fig. 2. The helix or curved line can now be drawn through the points of intersection of these lines.

The development of the helical surface will be found to be part of a ring plate, and it is only necessary to find the radii r and R and the angle α, shown in Fig. 3. The length of the inner edge is found from the formula $u = \sqrt{d^2\,\pi^2 + s^2}$, and that of the outer edge from the formula $U = \sqrt{D^2\,\pi^2 + s^2}$. U and u also might be found from Fig. 3, as $u = r$ arc $(360 - \alpha)$, and $U = R$ arc $(360 - \alpha)$. Therefore, arc $(360 - \alpha) = \frac{u}{r} = \frac{U}{r + b}$, because $R = r + b$. From this equation $r = \frac{u\,b}{U - u}$. Having found r it is only necessary to draw

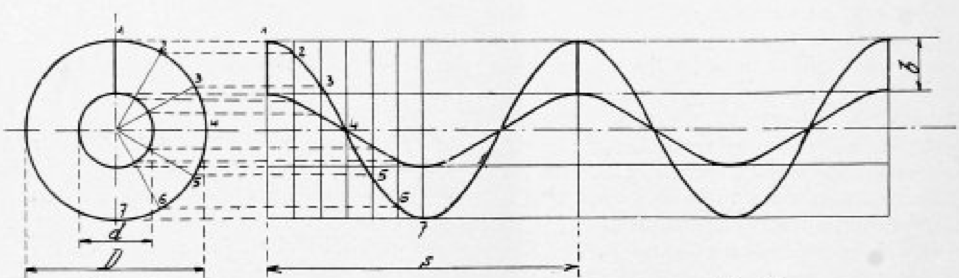


Fig. 1 *Fig. 2.*

the circles with radii r and $R = r + b$, b being the same as in Fig. 2. The lengths of one-half the arcs u and U can then be laid off from the center line on either side, and the development completed by drawing the straight lines forming the ends of the plate.

John Jashky.

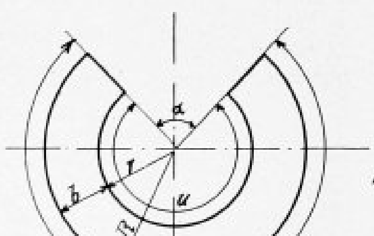


Fig. 3.

The Lukens Iron & Steel Company, Coatesville, Pa., the first maker of boiler plates in America, is arranging to fittingly celebrate the one hundredth anniversary of the establishment of its business. July 2 will be the date of the celebration, as it was on that date in 1810 that the deeds for the company's present location were signed.

The Sharon Fire Brick Works, Sharon, Pa., has the contract for firebrick required in relining Claire Furnace of M. A. Hanna & Company, at Sharpsville, Pa. This and other contracts enable it to operate its plant full capacity. The Sharon Boiler Works, builder of Wheeler watertube boilers, plate construction, etc., is furnishing a 300-ton Mullin gas washer for the same furnace.

How Long Will a Boiler Last?

BY EL'GOMO.

No doubt the above remark is frequently heard by the readers of The Boiler Maker, at least such has been the experience of the writer. The ultimate life of a boiler is a question. With the present scientific methods of making steel plate, and of constructing boilers and like vessels, it would seem that a comparatively long life might be guaranteed for a boiler. There are at this writing boilers in service known to be thirty to forty years old which show no special or local defects, but the reader will find in an earlier number of this journal an article referring to a large marine boiler built in Canada which failed under hydraulic test, and it developed that the solid plate proved the weakest part of the structure. This boiler failed below 50 percent of the calculated pressure.

Another instance worthy of mention can be vouched for by the writer who was one of the crew who made the boilers. The boiler in question was one of a battery in which there was nothing out of the ordinary in the way of material or workmanship. They were of the common cylindrical type, about 30 feet long by 30 inches diameter, made of ¼-inch plate, and single riveted with ⅝-inch rivets; the heads were of cast iron. The boilers were built and delivered in the month of August, and allowing four weeks for completing the installation, we can assume that they were ready for service about Oct. 1.

We were called to the mine on or about Dec. 27, the same year, to look the boilers over, word having been forwarded to the shop that the boilers were leaking. Examination showed slight seeping at the seams and rivets wherever exposed to view below the waterline, indicating loose rivets that ordinarily required renewing and necessitating an examination internally. They were found to be badly eaten away at all points below the waterline.

The owner of the mine shouted poor material. Now, the plates were of the ordinary steel used at that time (1880), yet the rivets used were the Burden, the best known at the time, so there was another reason which, after diligent research on the part of a chemist, was brought to light, viz.: that acids in the feed water had caused the trouble.

These acids, if the writer was correctly informed, emanated from a powder mill located up the stream or creek from which a certain by-product was allowed to flow into the creek. These boilers became useless within three months.

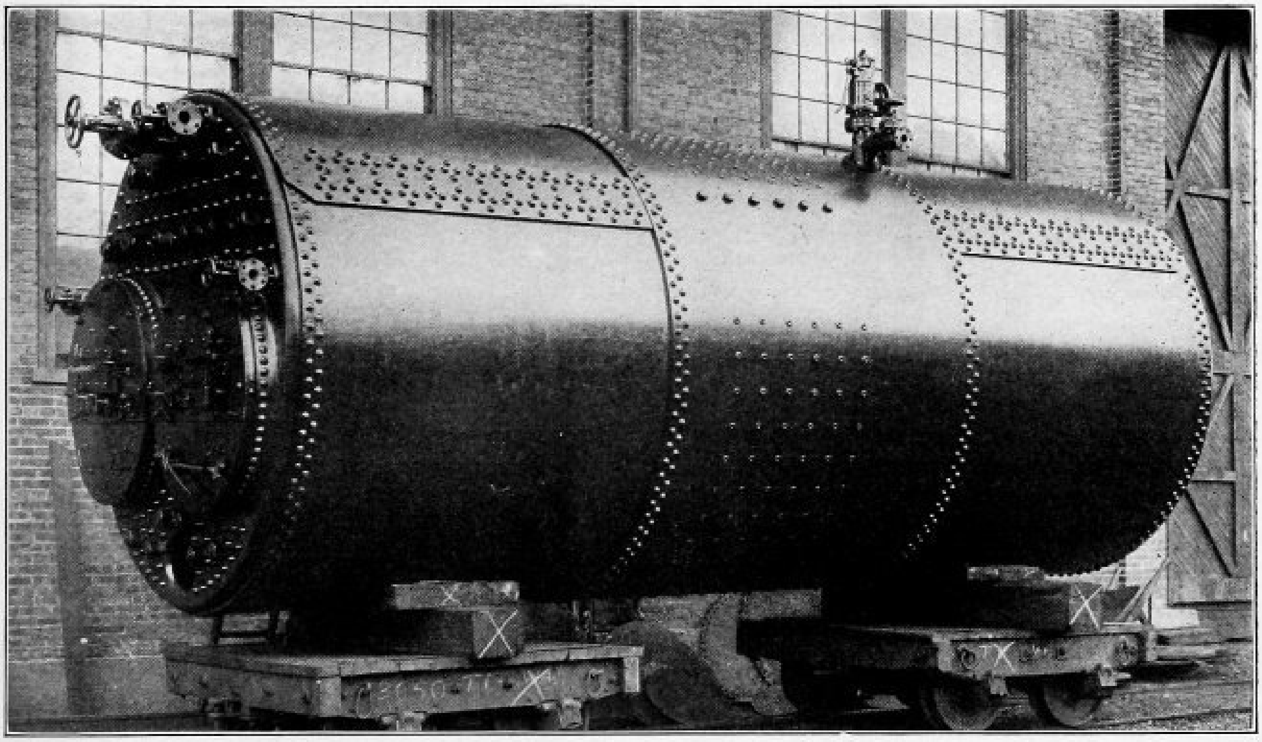
With so many things which can affect the life of a boiler it is impossible to say how long one will last. The main point is that the greatest care should be taken in operating the boiler to prevent corrosion, pitting and overheating, or over-stressing the material of which the boiler is constructed.

Every proprietor of a contract or marine boiler shop in the United States and Canada should plan to send his foreman boiler maker to the annual convention of the International Master Boiler Makers' Association.

BOILERS OF THE NEW WILSON LINE STEAMERS.

The Wilson Line, which has been operating the steamers *Brandywine* and *City of Chester* between Philadelphia, Pa., and Wilmington, Del., has just had built two new steamers, the *City of Philadelphia* and *City of Wilmington*. These new boats, like the older vessels, were built by the Harlan & Hollingsworth Corporation, of Wilmington, Del., and are splendid types of modern river steamers. Each vessel is 200 feet long over all, 31 feet beam at the deck, 41 feet beam over the guards, with a molded depth of 11 feet 4 inches. The hull is of steel, and is amply protected against damage through collision by means of water-tight bulkheads. Commodious and luxurious accommodations for passengers are provided.

Propulsion is by means of one set of three-cylinder, triple-expansion engines of the surface-condensing type. The boilers, a view of one of which is shown herewith, are of the straight-through or gunboat type, 9 feet 4 inches diameter by 22 feet long, constructed for a working pressure of 180 pounds per square inch.



EACH VESSEL IS FITTED WITH TWO GUNBOAT BOILERS; DIAMETER, 9 FEET 4 INCHES; LENGTH, 22 FEET; WORKING PRESSURE, 180 POUNDS PER SQUARE INCH.

Each boiler contains 2,100 square feet of heating surface and 41½ square feet of grate surface. There are two boilers in each vessel, the furnace gases being led through a single smokestack.

The smokestack is fitted with an outside air casing, having a large intervening space for ventilation. The stack is fitted with a steam jet of the Bloomsburg latest improved type, which is expected to add materially to the steaming capacity of the boilers.

The main steam pipes, where practicable, are made of steel, the remaining part is of copper, with specially designed bends, to allow for the expansion. A feed-water heater of the multi-coil type is fitted between the feed pumps and the boilers. All other details of the latest design have been installed in these vessels, so as to bring them in line with the latest practice in vessels of this class.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

An Opportunity that Comes but Once a Year.

Every boiler maker in the country should study carefully the programme of the forthcoming boiler makers' convention, printed on the opposite page. It will be seen that a wide variety of subjects will be brought up for discussion, and that each subject has been under consideration during the past year by a competent committee of at least four men who are prominently identified with the boiler-making industry. Many of the subjects have been discussed at previous conventions, and there can be no doubt as to the value of the information which will be brought out at the convention.

Having studied the programme carefully, and made sure that there will be something of value in it for himself, whereby he can show practical results as the direct benefit of his attendance at the convention, the boiler maker's next duty is to approach his employer and urge upon him the advantages which he would derive by sending his foreman to the convention. We believe that the majority of boiler makers are familiar with the work of the association, and the splendid results it is achieving, but we are well aware that this important work has not been placed before the manufacturers with as much emphasis as possible, and we believe that every manufacturer who fails to have a representative at the convention loses a valuable opportunity that comes only once a year to bring his shop work up to a higher point of efficiency. A glance at the list of officers of the association, and of the men responsible for the committee work, shows at once the high standard which is set by the association upon its work, and the association deserves not only a large attendance at its annual convention, but also a large increase in its membership and the support of every first-class foreman boiler maker in the country.

Exhibits at the Convention.

As has been stated in previous issues the arrangements at the "Clifton Hotel," where the convention is to be held, are such that exceptional exhibits of boiler makers' tools and supplies can be made, and this feature alone will be of much value to anyone attending the convention. In this connection exhibitors should note that in order to avoid all difficulty with the Canadian Custom House all exhibits should be shipped either by express or freight to Niagara Falls, N. Y., and the bills of lading sent to the Clifton Hotel, Niagara Falls, Ontario. If this is done the exhibits will be at the hotel as soon as the company's representative arrives, as the hotel management has made arrangements with the Canadian authorities whereby the goods may be brought over in bond. Also all baggage should be checked to Niagara Falls, N. Y. Further information can be obtained from the Boiler Makers Supply Men's Association, 17 Battery Place, New York.

Annealing Steel.

The heat treatment of steel is an important matter in boiler making. It is well known that working mild steel at a blue heat causes it to become brittle and crack, and that by heating it to a cherry red and allowing it to cool slowly the internal stresses caused by cold working can be removed, leaving the metal in a uniform condition. Annealing does more than that, however, if the steel has been heated to the proper temperature and cooled in the proper manner. It removes the coarse crystalizations caused by heating above the critical temperature, and thus brings the metal to the best possible physical state, when it will have the greatest ductility combined with the highest tensile strength. A certain change comes on in the steel during the process of annealing, and this change is wholly in the carbon content. Steel which is heated above the critical temperature, which is about 700 degrees Centigrade, corresponding to a red heat, contains only hardening carbon, and if the steel is suddenly cooled from this temperature the carbon will remain in this state and the steel will be hard and brittle. If, however, the steel is cooled slowly, a point is reached about 25 or 30 degrees Centigrade below the critical temperature at which the hardening carbon changes to cement carbon, and the steel becomes soft and tough. It is, therefore, important that the steel should be heated up to the critical temperature, when all previous crystalization disappears and the metal assumes the finest structure of which it is capable, and then cooled slowly and uniformly, allowing the hardening carbon to change to cement carbon, leaving the steel strong and tough. As it is not always possible to finish a piece of steel at a red heat, it ought to be finished as near the temperature at which the hardening carbon turns to a cement carbon as possible, since if finished below this temperature the grains are distorted, and in extreme cases, as when working at a blue heat, the steel fractures. It is therefore evident that annealing should be done with the greatest care and attention to detail.

BOILER MAKERS' CONVENTION.

Program of the Fourth Annual Convention of the International Master Boiler Makers' Association to be Held at the New Clifton Hotel, Niagara Falls, Ont., May 24, 25, 26 and 27, 1910.

SUBJECTS AND COMMITTEES FOR 1909-1910.

1. "Standardizing of Blue Prints for Building of Boilers." W. H. Laughridge, chairman; E. W. Rogers, James Beatty, G. W. Bennett.

2. "Best Method of Applying Flues. Best Method for Caring for Flues While Engine is on the Road and at Terminals and Best Tools for Same." D. A. Lucas, chairman; John German, E. W. Young, F. D. Avery, C. L. Wilson, J. R. Cushing.

3. "Flexible Stay-bolts Compared with Rigid Bolts. Best Method of Applying and Testing Same." C. J. Murray, chairman; H. J. Wandberg, W. G. Stallings, J. P. Malley.

4. "Steel vs. Iron Flues. What Advantage and what Success in Welding Them. Best Method of Applying Arch Brick." M. O'Connor, chairman; John McKeown, D. G. Foley, B. F. Sarver, C. L. Hempel, M. M. McAllister.

5. "Standardizing of Shop Tools." J. T. Goodwin, chairman; T. C. Best, William Horsley, Henry L. Wratten.

6. "Standardizing of Pipe Flanges for Boilers and Templates for Drilling Same. Which is the Long Way of the Sheet?" James Crombie, chairman; James T. Ward, B. H. Nudyke, R. W. Hazzard, Frank Atkinson, Charles Miller.

7. "Best Method of Staying the Front Portion of Crown Sheet on Radial Top Boilers to Prevent Cracking of Flue Sheet in Top Flange." H. J. Raps, chairman; A. N. Lucas, Frank Gray, J. H. Filcer, M. H. Larkin.

8. "Cause of Flue Holes in Back Flue Sheet Elongating and a Preventive for Same." J. A. Doarnberger, chairman; E. J. Hennessy, John B. Smith, William A. McKeown.

9. "To what Extent do Fire-Box Holes Crack, and what is Being Done to Prevent Same?" William H. Laughridge, chairman; James H. Fahey, J. H. Filcer, Henry L. Wratten, Wm. M. Wilson.

10. Proposed Changes in the Constitution and By-Laws. Charles P. Patrick, chairman; W. H. Laughridge, Thomas W. Lowe, Otto C. Voss, Thomas Werner.

11. Subjects: To recommend topics for committee reports at the next annual convention. William H. Laughridge, chairman; William Horsley, F. J. Graves, J. A. Doarnberger, Charles Munro.

FIRST DAY, MAY 24.

Convention called to order, 10.00 A. M.
Prayer, 10.00 to 10.10 A. M.
Address of weclome by Mayor of Niagara Falls, Ont., 10.10 to 10.25 A. M.
Response, 10.25 to 10.35 A. M.
Addresses, 10.35 to 11.30 A. M.
- E. M. Tewkesbury, G. S., So. Buffalo Ry.
- J. A. Tally, Buffalo, president Traveling Engineers' Association.
- Willard Kells, Buffalo, M. M., Lehigh Valley R. R.
- J. P. Murphy, Cleveland, secretary General Storekeepers' Association.
- C. W. Cross, superintendent of apprentices, N. Y. C. & H. R. R. R.

Responses, 11.30 A. M. to 12.00 M.
- Address, Col. E. D. Meier, New York City, president American Boiler Manufacturers' Association.

Routine business:
- Report of secretary, Mr. Harry D. Vought.
- Report of treasurer, Mr. Frank Gray.
- Appointment of committees.
- Miscellaneous business.
- Announcements.

Unfinished business, 12.15 to 12.30 P. M.
New business, 12.30 to 12.45 P. M.
- Appointment of special committees to serve during convention.

Adjournment.

SECOND DAY, MAY 25, 9.30 A. M. TO 1.00 P. M.

Report of committee on rules and formulas, 9.30 to 10.00 A. M.
Report of committee on standardizing of shop tools and equipment, 10.00 to 10.30 A. M.
Report of committee on standardizing of pipe flanges on boilers and templets for drilling same, 10.30 to 11.00 A. M.
What radical departures are being made in boilers and fireboxes? 11.00 to 11.30 A. M.
To what extent do fire-box holes crack and what is being done to prevent same? 11.30 A. M. to 12.00 M.
Announcements and adjournment.

THIRD DAY, MAY 26.

Report of committee on best method of staying front portion of crown sheet on radial top to prevent cracking of top flange of flue sheet, 9.30 to 10.00 A. M.
Report of committee on best method of applying flues, best method for caring for flues while engines are on the road and at terminals and best tools for same, 10.00 to 11.00 A. M.
Report of committee on steel vs. iron flues. What advantage and what success in welding them? 11.00 to 11.30 A. M.
Report of committee on flexible stay-bolts compared with rigid bolts. Best method of applying and testing same, 11.30 A. M. to 12 M.
Report of committee on standardizing of blue prints for building boilers, 12.00 M. to 12.15 P. M.
Report of committee on cause of flue holes in back flue sheet elongating and a preventive for same, 12.15 to 12.30 P. M.
Miscellaneous business announcements, 12.15 to 1.00 P. M.
Adjournment.

FOURTH DAY, MAY 27.

Report of committee on amendments to the constitution and by-laws, 9.30 to 10.00 A. M.
Report of committee on subjects, 10.00 to 10.15 A. M.
Report of auditing committee, 10.15 to 10.30 A. M.
Miscellaneous business, 10.30 to 10.45 A. M.
Unfinished business, 10.45 to 11.00 A. M.
Correspondence, resolutions, etc., 11.00 to 11.15 A. M.
Selection of next place of meeting, 11.15 to 11.30 A. M.
Good of the association, 11.30 to 12.00 M.
Election of officers and closing exercises of convention, 12.00 M. to 1.00 P. M.

THE WOMEN'S AUXILIARY.

The Women's Auxiliary of the association will also hold its annual meeting at the New Clifton Hotel at 10.00 A. M., May 27.

ENTERTAINMENT.

The order of entertainment will be announced in the convention at Niagara Falls, Ont.

OFFICERS FOR 1909-1910.

President, A. E. Brown, L. & N. R. R., Louisville, Ky.; first vice-president, A. N. Lucas, C., M. & St. P. R. R., Milwaukee, Wis.; second vice-president, Charles P. Patrick, general superintendent the Bigelow Company, New Haven, Conn.; third vice-president, Henry L. Wratten, superintendent boiler department Freeman & Sons Manufacturing Company, Racine, Wis.; fourth vice-president, Thomas W. Lowe, Winnipeg, Manitoba; fifth vice-president, George W. Bennett, N. Y. C. & H. R. R. R., Albany, N. Y.; secretary, Harry D. Vought, 95 Liberty street, New York City; treasurer, Frank Gray, 806 North Madison street, Bloomington, Ill.; executive board, J. T. Goodwin, chairman, American Locomotive Company, Richmond, Va.; H. J. Raps, I. C. R. R., Waterloo, Ia.; J. A. Doarnberger, N. & W. R. R., Roanoke, Va.; C. J. Murray, Erie R. R., Meadville, Pa.; M. O'Connor, C. & N. W. R. R., Missouri Valley, Ia.; James H. Fahey, F. B. M., J. I. Case T. M. Company, Racine, Wis.; W. H. Laughridge, Hocking Valley R. R., Columbus, Ohio; James Crombie, F. B. M., Sawyer & Massey Company, Hamilton, Ont.; B. F. Sarver, Pennsylvania R. R., Ft. Wayne, Ind.

COMMUNICATIONS.

A Suggestion.

EDITOR THE BOILER MAKER:

To the general reader of mechanical trade papers, such as THE BOILER MAKER, the correspondence columns are especially interesting, for much that is useful in our daily business may be gleaned therefrom. I consider that department of a paper very important and would like to see it occupy more space than at present.

Recently in your columns there has appeared quite a little discussion relative to triangulation, and also regarding the rule for the diagonal of a square, and it seems to me that much good is accomplished by learning what each side in an argument has to say concerning the points at issue. When we read the whole story things take on a slightly different complexion, and what at first we thought wrong shows up in a different light, and we are obliged to yield somewhat in our first opinions.

Let more such friendly discussions take place in future issues, from which all may derive at least some benefit and make the paper eagerly watched for month by month. For example, let some reader give his reasons at length as to why in a triple-riveted joint the outer row of rivets are spaced twice as far apart as in the other rows. Of course there is a reason, and many know it, but there are many who do not exactly understand why such a joint has a higher efficiency than if the outer row of rivets were pitched the same as in the inner rows. Let us hear from the readers about this matter.

Scranton, Pa. CHARLES J. MASON.

EDITOR'S NOTE.—We heartily endorse all that our correspondent says, and hope our readers will not only contribute freely to the discussions appearing in these columns but will also bring up many new interesting subjects for discussion. All letters accepted for publication will be paid for at our regular space rates.

Rule for Figuring a Capacity Gage for a Horizontal Tank.

EDITOR THE BOILER MAKER:

If any of the readers of your valued journal have had occasion to figure a scale or capacity gage for a horizontal cylindrical tank, they are no doubt aware of the extraordinary number of figures necessary to accomplish the result. The usual way of calibrating is to give the number of gallons per inch in depth, but in my experience I have found that this method of graduating will not fit every case, as a great many require the scale to show single gallons or the number of gallons in multiples of 2, 3, 4, 5, etc.

This method of graduating, however, is a more difficult problem and one not generally understood by the average student. A short-cut rule to accomplish this without using so many figures will therefore, no doubt, be appreciated by your readers. All that will be required is a table of areas of the segments of a circle, which can be found in Haswell, Kent or other similar text-books.

Assume the tank to be 40 inches in diameter and having a capacity of exactly 600 United States standard gallons.

Required to find the depth of liquid (in inches) when the tank contains 200 gallons.

Proceed as follows: Divide the decimal .3927 by one-half the total capacity of the tank: $.3928 \div 300 = .001309$. The decimal .001309 I will designate the constant. Multiply the constant by the number of gallons of which the depth is required: $200 \times .001309 = .2618$. Take the nearest versed sine for .2618, which, by reference to your table of areas, will be found to be .367. Multiply the versed sine by the diameter of the tank, and the result will be 14.680, or approximately 14 11-16 inches, the depth of 200 gallons. If the depth of 225 gallons is required, multiply the constant .001309 by 225, and proceed in the same manner as explained above for 200 gallons.

The writer has used this rule for a number of years, and during the time "tried out" a great many so-called short cuts, but I have never found one that will even approximate mine for simplicity. This rule, of course, can also be applied for Imperial (Canadian) gallons and for Mexican litros (metric system). The United States standard gallon contains 231, the Imperial 277.274, and the litro 61.022 cubic inches.

Ft. Wayne, Ind. G. A. SCHUST, M. E

Patch Bolts.

EDITOR THE BOILER MAKER:

The use of patch bolts, as applied to boiler and like repairs, is well known by the craft, and this means of securing patches, if properly done, is all that is desired in many cases, including locomotive, stationary and marine repair work. The writer can recall instances where locomotive furnaces were repaired with half-side and end patches, secured with patch bolts, and trouble was experienced with poor fitting bolts made in local shops, in place of purchasing standard size taps and bolts from specialists in that line.

The reader will no doubt recall instances where common plugs made from stay-bolt stock proved successful when properly fitted about ring corners. Why not apply this method for securing patches? The writer has observed a number of jobs on locomotive, stationary and marine boilers with patches secured in this manner, and the work was satisfactory. This method should prove an advantage over the countersunk-headed patch bolt, particularly as to time of fitting, driving and calking.

A few pointers in this direction may prove worthy of note and should suit most any shape of patch, including those with copper packing. Considerable saving should result by preparation. The writer would suggest the use of a twelve-thread plug tap or the ordinary patch bolt tap, usually 3/4 or 7/8 inch diameter. The stay-bolt rod can be cut any convenient length, and should be grooved at centers suitable for length required before threading the bolt its full length, and if properly grooved a clean thread will be left after cutting off each plug.

As the tap mentioned above is tapered, the threading of holes can be varied in size to insure a tight fit in making up the plug, particularly the inner sheet. The patch should be fitted close before the tap is used, and the excessive use of oil should be avoided.

With all bolts in place, use a heavy hammer on the plugs after the manner of driving staybolts, and use the hold-on where possible, although the writer has witnessed good results without the use of holding-on rig. EL'GOMO.

How to Prevent the Pitting of Boilers.

EDITOR THE BOILER MAKER:

Reading the article entitled "Pitting of Marine Boilers," page 98, in the April issue of your paper, reminds me of an experience that I had with pitting, only in my case it was a stationary boiler. Perhaps a recital of that experience may be of value to some of your readers, hence this letter. I was not at all astonished at reading of the failure of the Portland cement to make good in filling up the pit holes, as described in the article referred to. In fact, I cannot imagine anything that would give less satisfaction than cement for that particular purpose. While perhaps it is possible that the adhesive value of cement would make it suitable for such a purpose, the lack of elastic properties would certainly preclude its being considered at all; the repeated expanding and contracting of the plates would very soon crack the coating of cement, and once that would occur it would not be long before it would all come off, and leave the plates unprotected as at first.

Some few years ago I had charge of a power plant in which some of the boilers had begun to pit. Just about at the waterline a strip along each side of the shell 3 or 4 inches wide the pitting was not very deep, so we had a chance to arrest further action before the plates would be ruined. One boiler at a time was cut out of service and opened up. A man was sent in to thoroughly clean off the plates, using a wire brush to clean out the pit holes. After the surfaces had been cleaned a coat of thick paint, made of red lead and boiled linseed oil, was applied, and well brushed into the small pit holes. The paint was allowed to set for a few days before the boiler was closed up and made ready for filling with water and starting.

After operating the boiler for a month it was again cut out of service; opened up and the interior carefully examined. The red-lead paint was still in the pit holes and also on the flat surface of the plates surrounding the pitted portions. A file scraper was applied to see what the plate looked like under the paint. It was found to be in good condition. While the paint was hard and fast onto the surface of the plates, yet there was a certain amount of elasticity to it that permitted it to yield to the breathing action of the boiler. The only noticeable difference from the newly-painted appearance was that the color had changed from bright red to a dirty brownish red, due, no doubt, to being subjected to heat.

We gave this boiler another coat of the same kind of paint, ran it for another month, again cut it out of service and examined it as before. The pitting action had ceased, and the minute holes in the surface of the plates remained filled with the paint. All the boilers that had started pitting were treated in the way that I have described, and we were never again troubled with pitting, although I remained in charge for eight years—sufficient time, I think, to demonstrate the value of red-lead paint for that purpose. The Hartford Boiler Insurance Company's inspectors approved of the treatment, and so did the Municipal Inspection Bureau examiners, Brooklyn.

I may say that it is of the greatest importance that it be understood that boiled linseed oil must be used, not the raw linseed. We tried the raw oil one time, but it would not dry on the metal surfaces at all, while paint made by boiled oil would set quite firmly over night. The thicker it is made up—consistent with fluidity—the better it will serve the purpose. It cannot do the plates any harm, and certainly will protect the plates from corrosive action if it is followed up time and again as I have described.

Another method of arresting pitting is to use graphite mixed with some kind of an oil to the consistency of a paste. Fish oil is used for this purpose, although there are other oils that would do just as well. The paste graphite clings tenaciously to the surfaces and prevents further action of the water. I have not used this myself, but firmly believe it to be a good thing. As to whether it is as good or better than the red-lead paint could only be demonstrated by an actual trial with each, under similar conditions, for a sufficiently long period of time.

Scranton, Pa. CHARLES J. MASON.

A Correction.

EDITOR THE BOILER MAKER:

Referring to the development of a Y-pipe connection, on page 100 of the April issue of THE BOILER MAKER, you will find errors in the following statements:

"Referring to a table of tangents, 1.414 is given as equal to the tangent of 50° 44′, approximately; 180° — 54° 44′ = 55° 16′, approximate angle in full view between branch of Y-pipe 1 B.

"Angle between vertical pipe and Y will then equal 180° — 55° 16′ = 124° 44′, which is approximately 125°."

The foregoing should read:

Referring to a table of tangents, 1.414 is given as equal to the tangent of 54° 44′, approximately; 180° — 54° 44′ = 125°, approximate angle in full view between branch of Y and the pipe 1 C.

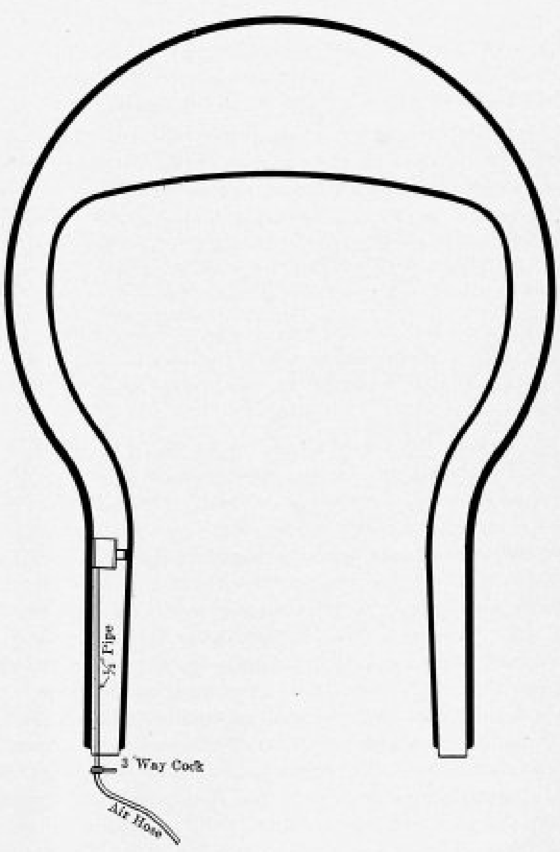
Angle between pipe 1 B and leg of Y will then equal 180° — 125° 16′ = 54° 44′, which is approximately 55°.

C. B. LINSTROM.

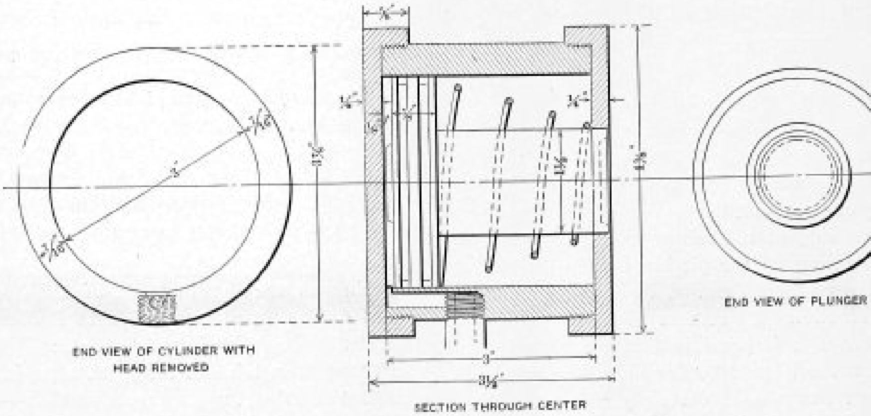
A Pneumatic Holding Device.

EDITOR THE BOILER MAKER:

The accompanying drawings show a device for holding on rivets with which we have been experimenting in our shop. We have found that it gives good service except that it does



HOLDER-ON IN PLACE.



DETAILS OF CONSTRUCTION OF THE HOLDER-ON.

not hold the rivets quite as solid as we think that it should. We have but 90 pounds air pressure, and you will note from the drawings the details of the construction of the machine, the size of ports and so on. We should like to get the opinion of readers of THE BOILER MAKER as to what should be done to make this machine a thorough success. Knowing that many of these machines are in use, undoubtedly many of your readers can tell us under what conditions they give the best service, and how we should change our designs to secure the best results.

EXPERIMENTER.

PERSONAL.

J. FAGAN has been appointed general foreman boiler maker of the Denver & Rio Grande Railroad, with headquarters at Denver, Col.

J. MITCHELL has resigned as general foreman boiler maker of the Denver & Rio Grande Railroad.

GEORGE SPRATLEY has been appointed foreman boiler maker of the Denver & Rio Grande Railroad, at Grand Junction, Col.

N. J. FRENZER has been transferred from the position of foreman boiler maker of the Denver & Rio Grande Railroad, at Grand Junction, Col., to other duties.

GEORGE MCCORKLE is now foreman boiler maker of the Denver & Rio Grande Railroad, at Salida, Col. Mr. McCorkle takes the position made vacant by the resignation of H. H. Adams.

WILLIAM SEIRCUT is the new foreman boiler maker at the Pueblo (Col.) shops of the Denver & Rio Grande Railroad, filling the vacancy caused by the resignation of Charles Schramm.

C. E. LESTER, for a number of years general foreman boiler maker, Erie Railroad, at the Meadville, Pa., shops, has resigned, and accepted a position as superintendent of the Davis-Bournonville (New York City) shops.

JOE HOLLOWAY, who is now engaged in general boiler work at San Bernardino, Cal., has had a wide and varied experience in boiler making covering many different classes of work in many different shops. Mr. Holloway comes from a mechanically-trained family, his father having been a boiler maker in England for sixty-three years. His brothers also were machinists. Mr. Holloway served his apprenticeship under his father, and from 1870 to 1881 was in the boiler department of the Burlington shops at Creston, Ia., and at various points along the line. From 1881 to 1890 he traveled extensively throughout the West, working principally in railroad boiler shops for the Central Pacific, Southern Pacific, Chicago, Burlington & Quincy, and the Atlantic & Pacific, and also in several contract shops in California. From 1890 to 1903 Mr. Holloway ran a sheet metal and boiler shop, and from 1903 to September, 1908,

JOE HOLLOWAY.

he was chief city boiler and elevator inspector at Los Angeles, Cal. Since then he has been engaged as engineer and as special inspector by the Santa Fe Railroad, in charge of comparative tests on locomotives.

LE GRAND PARISH, superintendent of motive power of the Lake Shore & Michigan Southern, has resigned to accept the presidency of the American Arch Company, New York. Mr Parish has been in the service of the Lake Shore for many years, and has served as superintendent of motive power on that line since early in 1906. His steady climb from storekeeper of the Lake Shore at Adrian, Mich., in 1891, to superintendent of motive power is a record that speaks for itself. He is second vice-president of the Master Car Builders' Association, with which he has been actively identified for many years, and in whose interest he has labored most effectively. He has also been active in the work of the Master Mechanics' Association and of the Western Railway Club, having served a term as president of the latter organization. Mr. Parish has had wonderful success in the handling of men, and is one of the best organizers among the railway officers of this country. The splendid organization of the motive power department of the Lake Shore is due largely to his personality and methods. The American Arch Company is a newly-organized corporation, and will make and sell locomotive arch brick. The company controls most, if not all, of the improved patented forms of arch brick which have heretofore proven mechanically and commercially successful. The new corporation will hereafter conduct the arch brick business previously done by the American Locomotive Equipment Company, Chicago, and the arch account handled up to this time as a department of the Franklin Railway Supply Company, New York. The officers of the American Arch Company are as follows: J. S. Coffin, chairman; Le Grand Parish, president; Charles B. Moore, vice-president; Samuel G. Allen, secretary and treasurer. The

LE GRAND PARISH.

principal office of the company will be at 30 Church street, New York, with branch offices at McCormick building, Chicago; 326 Endicott building, St. Paul, Minn.; 2318 Harney street, Omaha, Neb.; 327 Majestic building, Denver, Col.; 2319 Budlong avenue, Los Angeles, Cal., and 795 Monadnock building, San Francisco.

P. S. Hursh, formerly foreman boiler maker of the Buffalo, Rochester & Pittsburg Railway, at Du Bois, Pa., has resigned, to become manager of works for the Blaw Collapsible Steel Centering Company of Pittsburg. Mr. Hursh's headquarters will be at Reynoldsville, Pa.

The Mallet vs. Electric Locomotive.

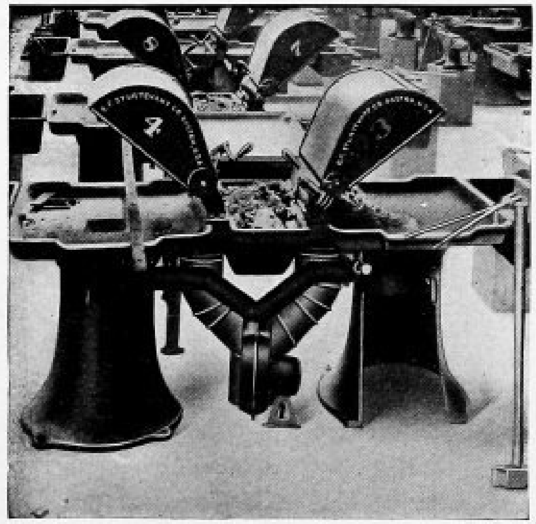
Commenting on the problem of electrification of the Central Pacific over the Sierras, Mr. Kruttschmitt, as reported in the *Wall Street Journal*, says: "Eastern critics may be inclined to the opinion that we are dallying with this matter. We have found that it pays well to make haste slowly with regard to innovations. Electrification for mountain traffic does not carry the same appeal that it did two years ago. Oil-burning locomotives are solving the problem very satisfactorily. Each Mallet compound locomotive having a horsepower in excess of 3,000 hauls as great a load as two of former types, burning 10 percent less fuel and consuming 50 percent less water."

Another case of admitting steam to a boiler with a man inside recently occurred in Cleveland. One of the employees, while at work inside of a boiler at the Teachout Boiler Works, was seriously scalded when someone accidentally turned a valve, filling the boiler with steam. As a result the man will probably be blind. Unable to find his way out through the blinding steam that enveloped him, he hammered on the side of the boiler and cried for help. He was heard by fellow employees at the plant and the steam was quickly turned off. He was assisted out of the boiler and attempted to walk to his home, but soon collapsed and was taken to his home in an ambulance.

ENGINEERING SPECIALTIES.

Sturtevant Electric Forge Blower.

The Sturtevant electric forge blower, manufactured by the B. F. Sturtevant Company, Hyde Park, Mass., is composed of a pressure fan of the multi-vane type inclosed in a pressed steel plate casing driven by a direct-connected electric motor built to operate from electric lighting circuits. The particular features of this blower set are compactness and high efficiency,



which it is claimed have been secured owing to the use of the multi-vane type of fan wheel. The principle on which this wheel is constructed is that of using many narrow blades in conjunction with a large air inlet. The illustration shows the installation of one of these sets connected to two forges. It is claimed that the same advantages can be gained by using individual blowers in forge work as can be obtained by using individual motors in driving machine tools, etc.

The blowing set weighs 35 pounds, measures 14½ inches from the floor to the top of the fan case, and 10 inches from the inlet of the fan to the outside end of the motor shaft. It can be installed to suit the requirements of individual cases as to location, etc.

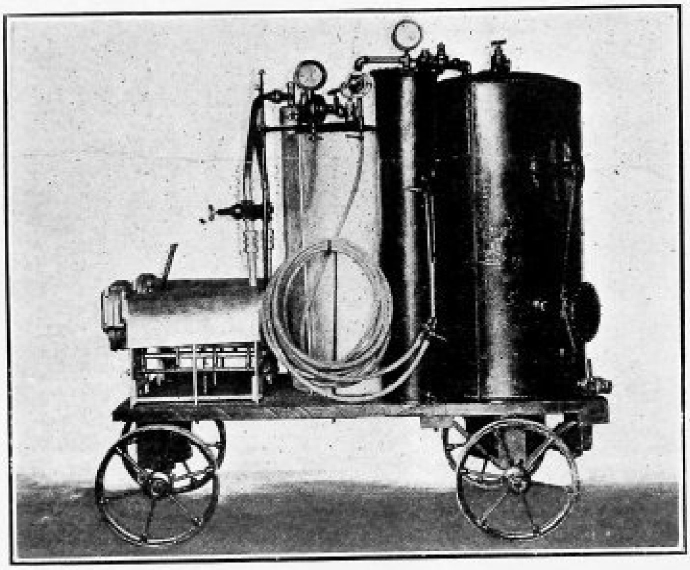
The company claims that with this blower connected to a forge with a tuyere area of 1.5 square inches, a 2-inch, round, soft steel bar can be brought to a welding heat in 4 minutes and a 1-inch bar in 2½ minutes.

Zynkara.

Zynkara is a solution of metallic zinc designed for use in marine boilers to supersede the use of metallic zinc plates to prevent pitting and corrosion. Since Zynkara is applied in solution it immediately distributes itself throughout all parts of the boiler, and thus is equally effective on each part of the boiler surface; whereas when metallic zinc plates are used they only give adequate protection to neighboring parts of the boiler. It is claimed that this compound reacts directly on the feed water of the boiler, preventing any chemical, and therefore any magnetic, action in the boiler, also destroying all oily matters which pass over from the cylinders, therefore preventing the deposit of such impurities on the furnace crowns and other dangerous parts of the boiler. It is also claimed to remove scale from boiler surfaces and replace it with a thin shell-like enamel or coating which is continually being thrown off and again being replaced, thus reducing time and cost of cleaning boilers to a minimum. Since Zynkara can be applied to a boiler daily while the boiler is in operation the engineer can always be sure that his boiler is protected; whereas, if metallic zinc plates are used they can only be renewed in port and may have become so corroded and covered with scale before port is reached as to have become practically useless. The compound is manufactured by the Zinkara Company, Ltd., Newcastle-on-Tyne.

Portable Welding Apparatus.

The large-size portable welding apparatus of the Oxy-Carbi Company, illustrated herewith, occupies a space of 26 by 64 by 64 inches. It has a carbide capacity of 30 pounds, which gives ample gas supply for large jobs. The carbide is placed in the holder through the upper hand-hole; generation



is started by hooking up the chain to the clamp screw; this makes it impossible to open the carbide chamber without dropping the chain; this allows the automatic valve to close the water-inlet passage, preventing water entering the chamber should there be unslacked carbide in it—at the same time it allows the escape of undue pressure should after generation take place in the holder. It is claimed that the action of this generator is entirely automatic, being governed by the consumption, and stopping positively without waste of gas at the safety valve, or without movement of valve or regulator if left indefinitely without attention after consumption is stopped. It may be operated in a small room without the odor of gas therein. The large purifier and filter insure a high quality of gas.

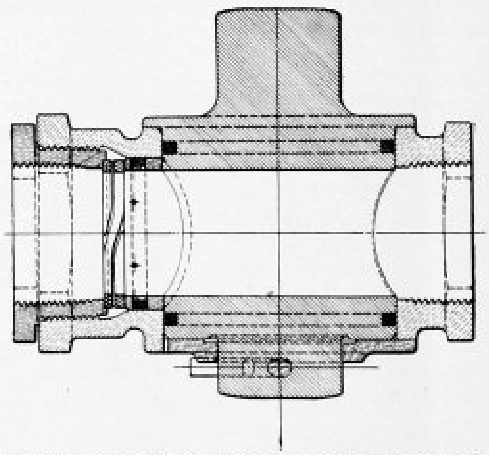
The oxygen generator has double retorts, which may be alternated when on large work, to supply the necessary amount of oxygen; the double gage arrangement makes this practical, eliminating all guess work as to the condition of the chemical in the retort in use, as the operator may tell in a moment by closing the inlet valve to the storage tank whether the gas is exhausted or not by the movement of the first gage. This is the Oxy-Carbi Company's exclusive feature, and obviates the unnecessary heating of the retorts and consequent economy of gas. This cannot be done when the conditions are unknown. Special alloy needle valves are used on the storage tank to retain the gas when not in use. These valves are the result of much experimenting with an endless variety of cocks and valves to find something that will stand the caustic action of the clorine.

This apparatus makes boiler repairs possible without removing the boilers from their settings or with very little trouble except to make room for the operator to work.

The Oxy-Carbi Company, of 516 Orchard street, New Haven, Conn., build these machines in 10, 20 and 30-pound sizes; they also build several different types of stationary apparatus.

The Caskey Compressed Air Valve.

The illustration shows a valve which was originally designed for hydraulic use and developed under a pressure of 10,000 pounds per square inch. This valve has been found to be equally effective at low pressures and has been adapted to compressed air pipe lines. The valve has a straight-through opening equal to the area of the hose with no change of direction, so that there is no opportunity or tendency to choke.



An adjustable sealing plug, which automatically takes up any slight wear, serves to keep the valve tight under all pressures. As the packing is not exposed it is claimed to be practically indestructible. These valves are made of manganese bronze in all sizes, from ¼ inch to 3 inches, by the Caskey Valve Company, 99 John street, New York.

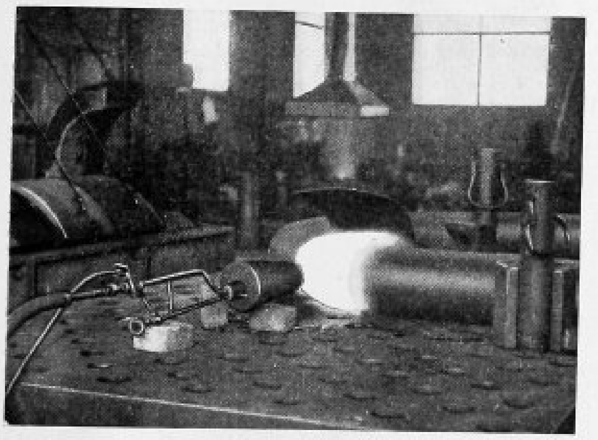
Apprenticeship Certificates.

Manufacturers are always looking out for some means of awakening ambition and inspiring better and more faithful service on the part of their employees, especially of the younger men who are trying to learn the business. One of the best aids for this purpose which has recently come to our attention is the apprenticeship certificate given by the Bantam Anti-Friction Company, of Bantam, Conn., makers of ball and roller bearings of all types, to the boys in their shops who have served their full three and one-half years' apprenticeship. The certificate states that "The recipient has duly served his full term as an apprentice in the machine shops of the above company, and has had all instructions possible in the operation of lathes, milling machines, drills, shapers, grinders, tool making, bench work and other practice usually found in machine-shop work. We can safely recommend him as a good and worthy machinist, reliable and conscientious in all of his work."

It is needless to say that a certificate of the above character, signed by the present and manager of the company, is a thing to be highly valued by the apprentice, and the company states that it has proved a very good incentive for work and something which the young men appreciate very much.

Pipe Bending.

The illustration shows a No. 2 Hauck burner, manufactured by the Hauck Manufacturing Company, Brooklyn, N. Y., heating a 10-inch iron pipe and bending it to a 4-foot radius.

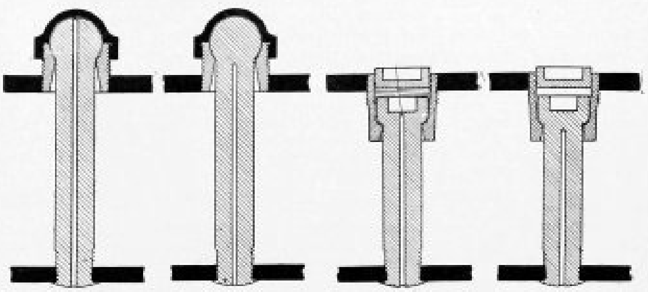


This work was completed in 1 hour and 10 minutes. It is claimed that by this method an almost continuous heat can be obtained and the heat applied just at the required place. In this particular job a proper heat of 18 inches in length was obtained in 6 minutes. It is claimed that the following operations are done away with if Hauck burners are used for pipe bending, as compared with coal fires. First, the placing and moving of the pipe to and from the forge; second, the turning and shifting of the pipe on the forge; third, carrying the heated pipe to the bending plate and fastening it into proper position, whereby a great amount of heat is lost before the pipe is ready to be bent.

Application of Falls Hollow Stay-bolt Iron to Flexible Staybolts.

The illustration shows a proposed application of Falls hollow stay-bolt iron, manufactured by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, to the Tate & Acme flexible stay-bolts. Two different methods of application are shown, in one of which the hollow iron is closed and upset at the headed end of the bolt. In the other the telltale hole is simply plugged at the headed end of the bolt.

Hollow stay-bolt iron has been found valuable where staybolt breakages are frequent, as a fracture in the bolt quickly makes itself known by the water issuing from the hollow stem. The hollow stay-bolt iron is also claimed to have the further advantage of increased strength to resist bending stresses, due to the method of manufacture, whereby the bar is rolled hollow. This latter advantage, of course, is maintained in the flexible bolt, but since it is necessary to close the end of the flexible stay-bolt in the outside sheet, the value of the hollow bolt as a telltale in case of fracture is somewhat diminished, since none of the water which reaches the channel



through a fracture will pass through the outside sheet. If, however, the escape of water into the fire-box is sufficient to detect a fractured bolt, it is at once apparent that a considerable advantage is gained by its use, since it is impossible to detect a broken flexible stay-bolt by the hammer sound on account of the head attachment. With the present form of flexible stay it is always necessary to remove the caps to determine whether or not a bolt is actually broken.

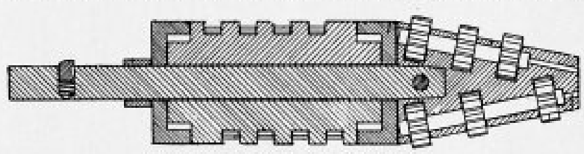
SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

945,125. TUBE CLEANER FOR WATER TUBES IN STEAM BOILERS. ELMER E. HAUER, OF SPRINGFIELD, OHIO, ASSIGNOR TO THE LAGONDA MANUFACTURING COMPANY, OF SPRINGFIELD, OHIO, A CORPORATION OF OHIO.

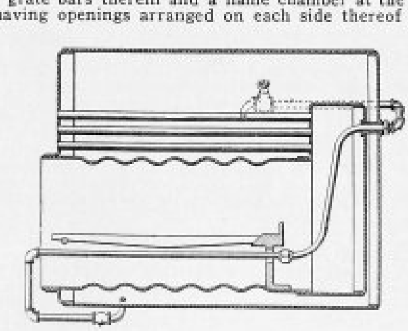
Claim 1.—In a rotary tube cleaner, a body portion divided longitudinally into non-pivoted radially movable sections, each section having a recess forming a central longitudinal aperture in said body, a shaft ex-



tending through said aperture and having interacting parts with the walls thereof to support and rotate said body, cutters mounted in said body and means to limit the radial movement of said sections. Six claims.

945,977. BOILER CIRCULATING DEVICE. FRANK H. NEWHALL, OF JUNEAU, DISTRICT OF ALASKA.

Claim.—The combination with an internally fired boiler having a fire-box with grate bars therein and a flame chamber at the rear thereof, said boiler having openings arranged on each side thereof in the lower



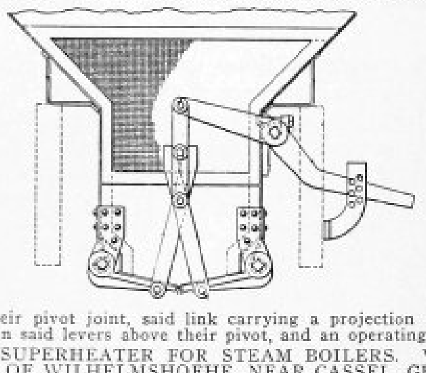
portion of its casing, of exit valves secured in said openings, horizontally arranged pipes connected at one end to said valves and extending to the front of the boiler and terminating at their upper ends at a point below the grate bars, elbows connecting the lower ends of said vertical pipes with the free ends of said horizontal pipes, parallel horizontal pipes arranged in the boiler casing below said grate bars and connected at their front ends with said vertical pipes, substantially S-shaped pipes extending longitudinally through said flame chamber and connected at one end with the rear ends of said last-mentioned horizontal pipes before entering said chamber, the other ends of said S-shaped pipes being extended through said boiler casing at opposite sides of the upper rear portion thereof, upper horizontal pipes, and couplings connecting one end of said upper horizontal pipes to the free ends of said S-shaped pipes, the other ends of said upper horizontal pipes entering the opposite sides of the boiler casing at points below the lowest water level of the boiler, said pipes being provided with inlet valves. One claim.

944,506. GRAVITY-SLIDE ASH-PAN. JOHN J. RYAN, OF HOUSTON, TEX.

Claim 1.—In combination with an ash-pan having bottom openings separated by a member arranged transversely of the pan between its ends having oppositely disposed guides, other guide members at the ends of the pan, and two pairs of oppositely movable valve plates slidable in said guides to close the bottom openings of the pan, one pair of said plates being devoted to each opening. Three claims.

946,440. LOCOMOTIVE ASH-PAN. HARRY A. HOKE, OF ALTOONA, PA.

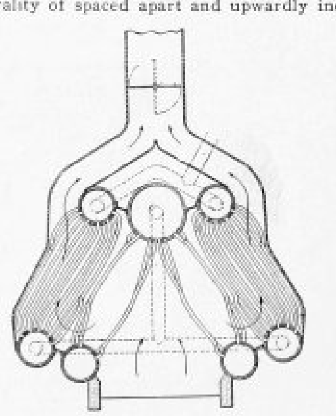
Claim 2.—In a locomotive ash-pan, the oppositely arranged pivotal drop doors, a pair of crossed pivotally jointed levers operatively connected respectively with the separate doors, a link connected with said



levers at their pivot joint, said link carrying a projection for engagement between said levers above their pivot, and an operating connection.

946,466. SUPERHEATER FOR STEAM BOILERS. WILHELM SCHMIDT, OF WILHELMSHOEHE, NEAR CASSEL, GERMANY.

Claim.—In a water-tube boiler having a steam superheater adjacent to and possessing steam connection therewith, a plurality of water tubes arranged in a plurality of spaced apart and upwardly inclined wall for-



mations approximately parallel to the axis of the boiler and separating the superheater from the fire box, said walls having openings at the top and bottom alternately, counting from the fire-box, whereby fire gases may pass between said walls to the superheater. Six claims.

945,322. MECHANICAL STOKER. HENRY J. C. GIESEKE, OF JERSEY CITY, N. J.

Claim 2.—In a mechanical stoker, the combination of a trough having a gradually decreasing depth from front to rear, sliding side bars, blades pivoted to said sliding bars, a connecting rod pivoted to said blades, and means for reciprocating said connecting rod, said blades gradually decreasing in depth from front to rear. Seven claims.

948,220. LOCOMOTIVE AUTOMATIC STOKER. STANTON D. GRIFFIN, OF WEST POINT, MISS.

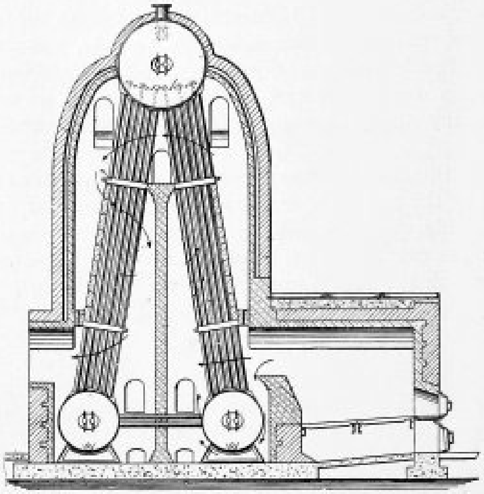
Claim 2.—In an apparatus of the class described, a locomotive and tender therefor, a receptacle opening at one end into the tender and at its other end into the furnace of the locomotive, a conveyer operating in the receptacle, driving means for the conveyer, a grate-carried reciprocating bar, a gear wheel operatively connected with the said reciprocating bar, said driving means for the conveyer having a driving chain which is disposed immediately above the said gear wheel, and means for engaging the said chain with the gear wheel for simultaneously reciprocating the said bar upon operation of the conveyer. Two claims.

946,804. SPARK ARRESTER. LAURITZ MILLER, OF LARAMIE, WYOMING.

Claim 2.—A spark arrester comprising a smokestack having integral annular interior flanges and a separable auxiliary depending cylindrical extension provided with annular flanges depending from the interior walls thereof, annular foraminous extensions secured to said flanges, and deflectors the deflecting surfaces of which are substantially at an angle similar to that of the annular flanges, and adapted to direct the sparks and solid particles of the exhaust into the annular pockets or channels formed by the said flanges. Six claims.

948,271. BOILER. GODFREY ENGEL, OF PITTSBURG, PA.

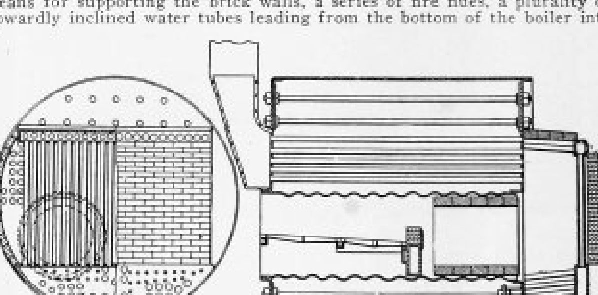
Claim 2.—In a boiler, the combination with a circulating system comprising a plurality of drums, upper and lower, and a plurality of connecting banks of generating tubes arranged for circulation of water between said upper and lower drums, of means for directing heating gases along said tubes comprising separate passages, each inclosing one of



said banks of tubes connecting the upper and lower drums, and arranged substantially longitudinally with respect to said tubes, said passages connected in series and transverse baffles in said passages, one of said baffles in the first such passage and extending across tubes therein. Thirty-eight claims.

948,366. STEAM BOILER. THOMAS BARROW, OF DETROIT, MICH.

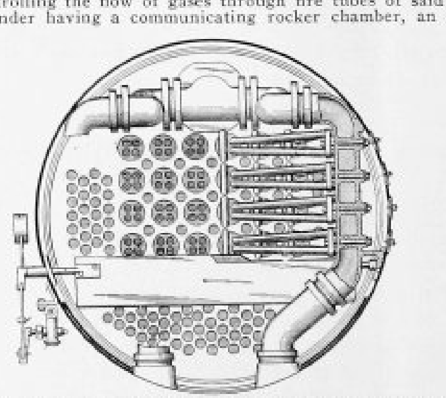
Claim 1.—In a boiler, a header provided with openings, vertical tubes bridging said openings and connecting the upper and lower parts of the header, brick walls closing said openings and spaced from said tubes, means for supporting the brick walls, a series of fire flues, a plurality of upwardly inclined water tubes leading from the bottom of the boiler into



the header, a plurality of upwardly inclined water tubes leading from the header back to the boiler, but below the fire flues, and an arched wall bridging the space between the end of the boiler and the header above the water tubes and spaced therefrom. Two claims.

949,147. STEAM BOILER SUPERHEATER. FRANCIS J. COLE AND HENRY B. OATLEY, OF SCHENECTADY, NEW YORK.

Claim 2.—The combination, with a steam boiler, of an oscillatory damper controlling the flow of gases through fire tubes of said boiler, a damper cylinder having a communicating rocker chamber, an operating



shaft journaled in said rocker chamber and coupled to the damper, a piston fitting in the damper cylinder and open continuously to an avenue of steam supply from the boiler, a rocker fixed on the operating shaft and engaging the rod of the damper cylinder piston, and a counterweight fixed to the damper in position to exert its gravity in opposite direction to the action of the damper cylinder piston. Five claims.

THE BOILER MAKER

JUNE, 1910

A JAPANESE WATERTUBE BOILER.

The Miyabara watertube boiler, which is widely used for marine and stationary work in Japan, is a boiler built without flat or stayed surfaces, the entire boiler consisting of drums and curved tubes. The illustration shows the general arrangement of drums and tubes, as used in a double-ended marine boiler. It is claimed that this boiler is a practical boiler in every way, as it is simple in construction, easy to handle, and an efficient steam producer. It involves no new features of construction, and, in fact, could be manufactured or repaired by any boiler maker. Due to the arrangement of the nests of tubes, it is very elastic and easily accommodates itself to the changes due to expansion and contraction. The smallest boilers of this type are 2 feet wide by 2 feet 3 inches deep by 3 feet high, while the largest are 12 feet 6 inches wide by 18 feet long by 14 feet high with a heating surface of about 4,800 square feet.

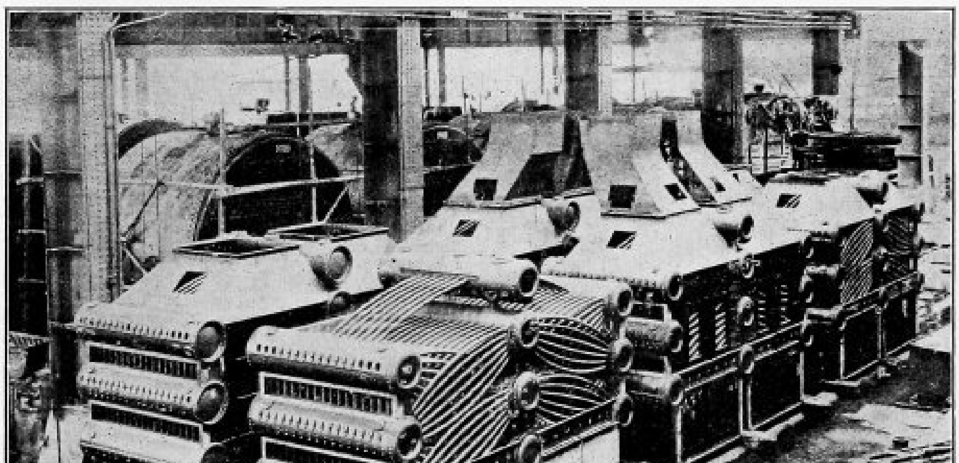


FIG. 1.—MIYABARA BOILERS FOR H. I. M. S. MOGAMI, 8,500 I. H. P. TURBINE CRUISER.

The arrangements for superheating are such that the boiler can be changed to a superheated steam generator without adding or fitting special apparatus, as in other types of watertube boilers. The superheater, therefore, requires no extra weight or space.

This type of boiler was installed in a number of the Japanese warships which saw service in the recent Russo-Japanese war, and the satisfactory results obtained from them for this service are worthy of mention. The Miyabara boiler proved to be the only type in the entire Japanese fleet which could be kept under steam for six months without cleaning the inside, thereby proving that a rapid and efficient circulation of water is maintained under all conditions. As indicating the durabilty of the boiler; one of the Japanese cruisers which was fitted with this type of boiler never returned home during the war, while her two sister ships, fitted with other types of watertube boilers, were sent home to be re-tubed, although all three were sister ships, and had been re-boilered at exactly the same time, and had since undergone the same service. In 1907 the first class Japanese cruiser *Tsukuba*, of 23,000 indicated horespower, made a long, trying cruise of 35,000 miles. This cruiser is fitted with Miyabara boilers, and throughout the cruise there was not a single part in her boilers proper which required repairing or renewing.

The steamship *Sakura Maru*, which is equipped with Miyabara boilers, and Parsons turbines of 9,000 shaft horsepower, has been running between Kobe and Formosa for the last eighteen months, at an average speed of 16 knots, making three trips of 6,000 miles each per month, burning 6½ tons per hour, of poor caking, dust coal of cheap grade, the rate of combustion being just about 30 pounds per square foot of grate per hour with natural draft, developing an average of about 4,500 shaft horsepower at the turbines. This vessel has given excellent satisfaction and no trouble has been experienced with her boilers, although her firemen have been frequently changed and almost every time the boilers were handled by fresh hands, who had no previous knowledge of any type of watertube boiler.

These boilers have evidently been immune from the minor explosions and accidents which frequently attend the use of watertube boilers. Over 340,000 horsepower of them have been in use both for land and marine purposes, and up to

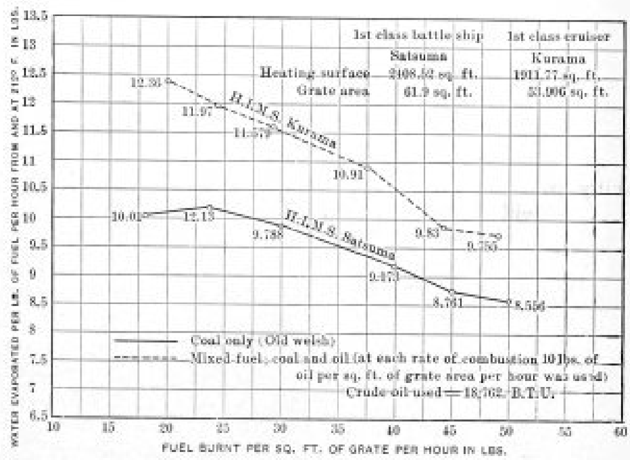


FIG. 2.

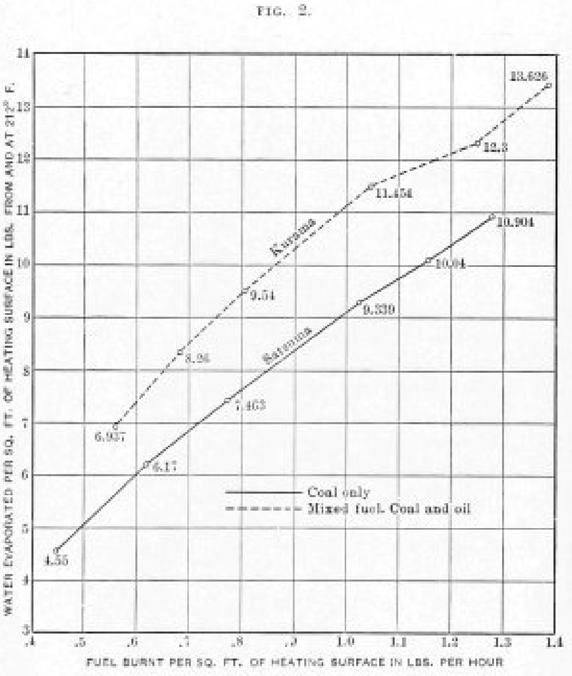


FIG. 3.

this date not a single tube has burst or exploded, in spite of the very rough usage which some of the boilers have undergone. It is claimed that the feed water may be neglected for thirty minutes when under the hardest forced draft and working at full power. Some idea of the weight and power of the boilers may be obtained from the following table:

	Turbine 23-Knot Cruiser Mogami.	Despatch Cruiser Yodo.	First Class Cruiser Tsukuba.
	Pounds.	Pounds.	Pounds.
Weight of boiler per I. H. P.	29.8	33.37	53.98
I. H. P. per ton of boiler weight	74.9	66.1	41.6
I. H. P. per square foot of grate surface	16.1 (S. H. P.)	17.4	17.99

NOTE.—Boiler weight = Boiler weight with water all complete, ready for use but not including uptakes and funnels.

The first class armored cruiser *Ibuki*, equipped with Curtis turbines of 27,000 shaft horsepower and fitted with ten double-ended and eight single-ended Miyabara boilers, with a total heating surface of 59,040 square feet and a total grate surface of 1,648 square feet, working at a pressure of 250 pounds per square inch with superheaters, has a record of coal consumption of 1.99 pounds per shaft horsepower when developing 21,000 shaft horsepower on her coal consumption trial, and of 2.03 pounds during her full-power trial when developing 27,242 shaft horsepower under a forced draft of from ½ to ¾ inch of water. These boilers are fitted with superheating tubes of very moderate superheating capacity, the average superheat at full power being about 50 degrees Fahrenheit. From the foregoing, the shaft horsepower per square foot of grate surface is 16.4 and the indicated horsepower per square foot of boiler room floor area is 5.47.

Figs. 2 and 3 show the results of some recent evaporative trials of Miyabara boilers for the first class battleship *Satsuma* and the first class armored cruiser *Kurama*, while the following table shows the results of tests on the boilers of the *Tsukuba*.

Miyabara boiler for cruiser *Tsukuba* (23,000 I. H. P.)

G. S. = 67.5 sq. ft. H. S. = 2374 sq. ft

Steam generating tubes 2 inches dia. No. 9 S. W. G. thick.

Trials carried out carefully and strictly at Kure Naval Dock Yard according to the naval regulation.

Type of boiler	Miyabara Watertube Boiler S. E. Type.					
Duration of trial in hours	8	8	8	8	8	8
Coal, kind of	Welsh	Welsh	Welsh	Welsh	Welsh	Welsh
Steam pressure, pounds per square inch	188.5	191.3	201.8	185.6	184.	191.3
Coal burned per square foot heating surface in pounds	0.279	0.418	0.559	0.668	0.84	1.114
Coal burned per square foot grate surface in pounds	9.8	14.7	19.6	23.52	29.4	39.8
Water evaporated per pound coal from and at 212° F	10.323	10.492	10.48	9.467	8.731	8.629
Water evaporated combustible from and at 212° F.	11.92	11.85	11.75	10.58	9.73	9.61
Water per square foot heating surface from and at 212° F	2.786	4.384	5.839	6.32	7.297	9.616

Note.—The coal used was ordinary commercial Welsh coal obtained in the Japanese market, unavoidably old and poor, so that to make a fair comparison with evaporative efficiencies of those well known watertube boilers in Europe and United States, where the results are obtained by using new and best picked coal and expert firemen, at least 10 percent allowance must be made on the performance above stated.

The Miyabara boiler has also been adapted to locomotive use, and is one of the few designs for a locomotive boiler built entirely as a watertube boiler.

We are indebted to Engineer Vice-Admiral Baron J. Miyabara, formerly Chief Engineer of the Japanese Navy, for the foregoing illustrations and data.

High-Speed Machine Riveting.—The use of compression riveting machines has made it possible to drive a considerably greater number of rivets in the same amount of time than could formerly be done by hand. This is undoubtedly due to the fact that the machine drives the rivet by one squeeze, and that the time is consumed, not in driving the rivet but in moving from one rivet to the next. According to the Chester B. Albree Iron Works Company, Allegheny, Pa., a record of 12,000 hot ¾-inch rivets in ten hours was recently established with a compression riveter. When it is considered that the best previous record was 10,000 rivets, and that for boiler work, where the joint must be steam tight and the rivets well driven, 1,000 to 1,500 rivets is considered good work, and on structural steel, such as girders, from 3,000 to upward to 4,000 is generally driven, and for irregular work, such as trusses, the number probably falls as low as 2,000 to 2,500, the economy resulting from the use of a compression riveting machine is apparent.—*The Iron Age.*

THE INSTALLATION OF FLEXIBLE STAYBOLTS.

BY M. M. MCALLISTER.

In the application of Tate flexible staybolts to new fire boxes at the Collinwood Shops of the Lake Shore and Michigan Southern Railroad, we first drill out the old bolts with a twist drill ⅛ of an inch below the diameter of the bolt, having prick punched the bolt in the center, after chiselling off the end, and run the twist drill in a sufficient depth to pass the thickness of the sheets (about ½ inch) and then use a Wagstaff staybolt cutter to cut through the staybolt, leaving a thin shell of the old bolt in the sheet. When all the bolts have been drilled in this manner the sheets with the rivets removed are pulled out, and the shells of the old bolts in the outer sheet are collapsed with a chisel until separated, leaving the outer shell all ready for either a new sheet or a new fire-box, whichever the case might be.

In applying new fire-box sheets, after same have been located and riveted up to the mud-ring, the staybolt holes are drilled and tapped out with a regular drill and staybolt tap, run through both the inner and outer sheets, as ordinarily done; then we enlarge the holes in the outer sheet for the sleeves of the flexible stay-bolt, with a flat drill, made of high speed steel, running 280 revolutions per minute, and applied to a motor, following with a roughing taper reamer, which is well lubricated, which leaves the hole of the proper dimensions and taper for the tap which is used for the flexible staybolt sleeve.

In tapping the large holes for the flexible staybolt sleeves we first run a straight tap and then a taper tap, by motor whose power is compounded, at a speed of 280 revolutions per minute, using a collar on the taper tap as a gage to keep it from going in too far and tapping the holes too large for the required sleeve, to be used according to the thickness of the plate. The straight tap is used to block out the metal, and the taper tap is used to size up the hole, for the regular taper with full threads, using lubricant sufficient to keep the taps cool and make a nice smooth thread in the sheets.

In case new sheets are used for the outside, and also new side sheets for the fire-box, we drill holes ⅞ inch in diameter for 1 inch bolts, tapping the size for the bolt; then after tapping through both sheets with a regular tap, giving us a small hole in the inner sheets with a regular standard, the hole in the outer sheet is then drilled and tapped as before described. We believe this is the most practical way of cutting the holes in line, using, however, guide bars in the roughing reamer, straight tap and taper tap in machining the large hole in the outer sheet for the flexible staybolt sleeve.

It is a good practice to have two sets of tools, and while using one set allow the other to remain in oil to cool off, providing small buckets with sufficient oil to cover two-thirds of the tools, which are placed in the oil in upright positions.

In the use of the roughing reamer, straight tap and taper tap, guide bars should always be attached to the tools to engage with the hole in the inner sheet, affording a stiff connection for maintaining alignment.

Braces are bolted to each end of the sheet in the shape of forged arms, extending out as to take a three-inch plank, which extends from one arm to the other, known as "Old Men," used to brace and support the motor during the operations of machining and allowing for the use of two gangs of operators on the same side of the boiler at the same time, and by moving the braces and plank and following up the side of the boiler, the whole arrangement affords a ready means of making the operation of drilling comparatively easy and saves time.

The question has often been asked, "Why not punch the large holes?" In punching a hole for the flexible staybolt sleeve in half-inch or nine-sixteenths material, it is very apt to distort the material to such an extent that it is considered dangerous, and this practice should be discouraged, inasmuch as in the process of bending the outer sheet to conform to the contour lines of the boiler, the large holes that have been previously punched render the operation of bending unsatisfactory, and after the sheet is bent the punched holes do not ream up as perfectly as the enlarged holes before mentioned.

After the holes in the outer and inner sheets are tapped the flexible staybolt sleeves are screwed into the outer sheets by a stud nut, using a wrench about three feet long, until the sleeve is screwed to a steam-tight fit, after which we insert the bolt through the sleeve, screwing it into the threads of the inside sheet by using a bolt driver in a motor until the head of the bolt almost engages its seat, then screwing the bolt with a hand driver until it seats snugly, when it is turned back about one-quarter turn, as it is necessary to maintain a natural hanging of the sheets when all bolts are riveted up, and the riveting up has a slight tendency to draw the bolt up to the sleeve seat. This method is more apt to give an even tension over the entire area of sheet and is recommended as good practice.

To prevent sleeves from loosening in the outer sheet while the operation of riveting up the staybolt end which enters the fire-box is performed, we use instead of the ordinary dolly-bar and holder-on a bushing which screws over the sleeve of the flexible bolt, in the center of which is a plunger or pin with the end formed half round to conform to the shape of the bolt head and so contained that the pin remains at all times central to the staybolt during the riveting, while the jar or thrust from the dolly-bar held on the end is less liable to affect the sleeve. This arrangement, or something similar, is much better than holding-on in the usual way; in fact, it is necessary for the proper application of the flexible staybolt.

After the bolts have all been riveted up, it is well to gage each bolt head from the end of the sleeve where the cap makes its seat, to prove that the bolt is well seated in the sleeve and clearance is allowed between bolt head and cap. A good gage is made by sawing a cap in half and removing the threads, thus giving two gages which can be readily placed on the sleeve seat, showing the clearance left between the bolt head and cap.

With the foregoing operations properly performed and inspection carried on after each operation to insure that all machining and riveting is correct, the caps are then screwed on to the sleeve by first brushing the cap threads lightly with graphite and cylinder oil, mixed thin. The caps are screwed up tight, and should screw over the sleeve easily, so as to make a snug steam-tight fit on the face of the sleeve.

The sleeve face is squared up to engage with the similar surface in the cap, and before screwing on the cap it is well to inspect the sleeve surface on the end to see that no hammer marks or burrs will prevent the making of a tight joint. In case such are discovered they should be removed and no difficulty as to fit will be found.

Our experience proves the fact that when all machine operations are performed with care as to size, and general inspection made quickly following each operation, when all are found to be right, the assemblage when finished is perfect and little or no annoyance or difficulty will be found in the perfect working of the flexible stay.

The total cost of applying flexible staybolts, such as we apply, should not exceed 15 cents for labor, with one boiler maker at 32½ cents, and a helper at 18 cents per hour. When driving bolts one more boiler maker is required.

The new plant of the Western Dry Dock & Shipbuilding Company, at Port Arthur, Ont., is to include a large, completely equipped boiler shop.

EXPANSION OF LOCOMOTIVE BOILER SHEETS.*

Important facts concerning the inequality of expansion in locomotive boilers, based upon thoroughly practical tests and observations of boilers in operation extending over a long period, were brought out by D. R. MacBain, superintendent of motive power of the Lake Shore & Michigan Southern, in an illustrated address at the May meeting of the New York Railroad Club. The most important fact was that with the fire at a high temperature and good circulation in the boiler the outer firebox sheets expand more than the inner ones. The tests which showed this can best be described in Mr. MacBain's own words:

"Fig. 4 shows some tramming done to determine if, under certain conditions, there is a difference between the amount of expansion that takes place in the inner and outer sheets of a firebox. This work was carried out most carefully and under conditions which we believe were such as to give a very fair idea of what takes place in a locomotive firebox when the temperature of the fire is high and circulation of water is good. The process of making these determinations was as follows:

"A wide firebox boiler was selected; trams of solid steel were prepared, and a set of marks were made on the inner and outer sheets from these trams. The boiler was then fired up and, when the pressure reached 200 lbs. and the pops had been open for a few minutes, the fire was drawn hastily, during which process the trams were tried to their respective marks on the outside sheets; immediately afterward (within a few minutes) the trams, in the proper order, were tried to the marks on the inner sheets, and the data shown below is the result, indicating that the expansion of the outer sheets of the firebox was greater, in every case, than that of the inner sheets.

Mark.	Outside Wrapper Sheet.		Inside of Firebox.		Difference in Expansion.
	Location.	Expansion.	Location.	Expansion.	
No. 1	Side sheet	3/16-inch	Side sheet	1/8-inch	1/16-inch
No. 2	Side sheet	5/32-inch	Side sheet	3/32-inch	1/16-inch
No. 3	Side sheet	1/4-inch	Side sheet	5/32-inch	3/32-inch
No. 4	Side sheet	3/16-inch	Side sheet	1/8-inch	1/16-inch
No. 5	Side sheet	7/32-inch	Side sheet	1/8-inch	3/32-inch
No. 6	Wagon top	7/32-inch	Crown sheet	5/32-inch	1/16-inch
No. 1	Throat sheet	5/32-inch	Tube sheet	7/64-inch	3/64-inch
No. 2	Throat sheet	3/16-inch	....	1/8-inch	1/16-inch
No. 1	Back head	5/32-inch	(No record on	door shee..)	

This apparently accounts for the breakage of the back heads and throat sheets along the outer row of staybolts; also the vertical cracks in the side sheets as well as cracks at the water-bar holes. When the fire was first started, and before circulation was fully established, the needle extending through the throat sheet moved out 3/32 inch, and later, when circulation was established and the steam pressure began to raise, the needle moved backward about 1/16 inch. The first movement of the needle throws some light on the cause of side sheets puffing along the fire line, as they sometimes do.

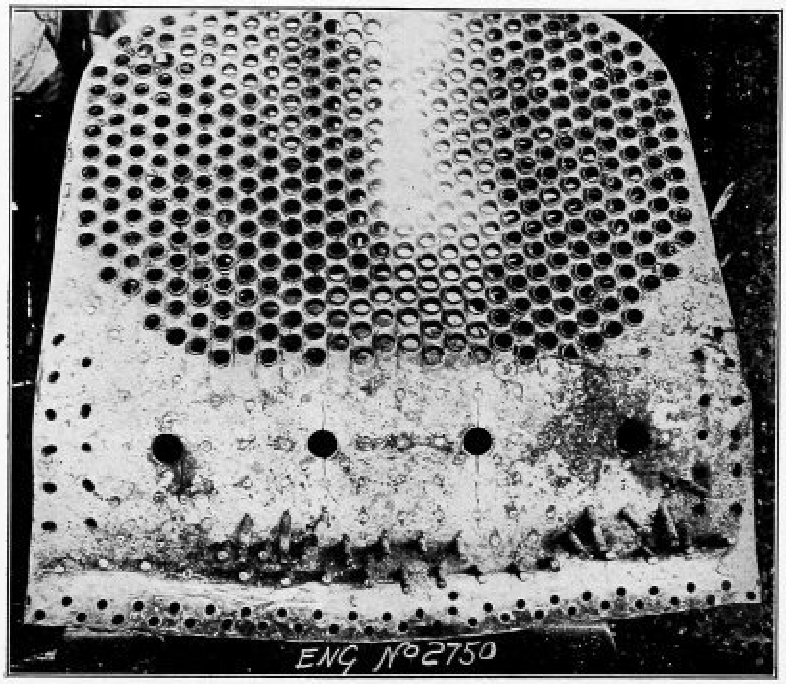


FIG. 1.—BACK FLUE SHEET CRACKED FROM THE ARCH-FLUE HOLE, UP AND DOWN, ATTRIBUTED TO THERE BEING MORE EXPANSION, TRANSVERSELY, IN THE OUTER SHEET THAN IN THE FLUE SHEET ACROSS THE BOTTOM WHERE THE CRACKS OCCUR.

The diagram in Fig. 5 shows the result of a record investigation made by F. A. Linderman, supervisor of boilers of the New York Central & Hudson River, to determine the direction and extent of expansion in a flue sheet resulting from prossering in a set of new flues. The inner or dotted circle was scribed before the flues were put in and the outer one after they were prossered. The expansion of the sheet is very noticeable, especially at the top. This distortion is serious, especially when the process of prossering is employed at least once every 30 days during the time the engine remains out of the shop. "It has been our experience that the prosser expander is less injurious in this respect than the ordinary roller expander, but, nevertheless, the question 'What can be done to curtail the use of expanders of any kind in making running repairs?' seems to be in order."

Fig. 6 shows the firebox of a large Pacific type locomotive,

* From the "Railway Age Gazette." Abstract of an address delivered before the May meeting of the New York Railroad Club.

to which templates were fitted while the boiler was cold, and the effect in movement of the templates when steam was raisd to 200 lbs. pressure. The templates lifted 3/32 in. at each end, and had their bearings on the wagon top extending between points A and B, the zone covered by the three rows of bolts that caused trouble through excessive breakage. Another set of templates was fitted to a boiler of similar design, into which a special installation of flexible staybolts had been made, and, under hydrostatic test, up to 25 percent above the rated steam pressure, the templates retained their fit on the wagon top, apparently indicating that the distortion noted above was due to expansion and not to pressure or to the use of the flexible staybolts.

sheet seam. The engine has never been held one moment for boiler work, other than that of expanding the flues, since it went into service in February of 1907.

Inasmuch as it has continually carried a double brick arch—the old Coffin-McGeath brick arch installation—the record of this side-sheet seam is remarkable. It is believed that the results obtained are due to the loose installation of staybolts and radial stays referred to above.

To ascertain, if possible, why the back flue sheet, and the front one, too, for that matter, become deflected or distorted, the New York Central installed a set of flues in one of their large Pacific type locomotives about one year ago. The theory was that while the locomotive was working and the fire hot,

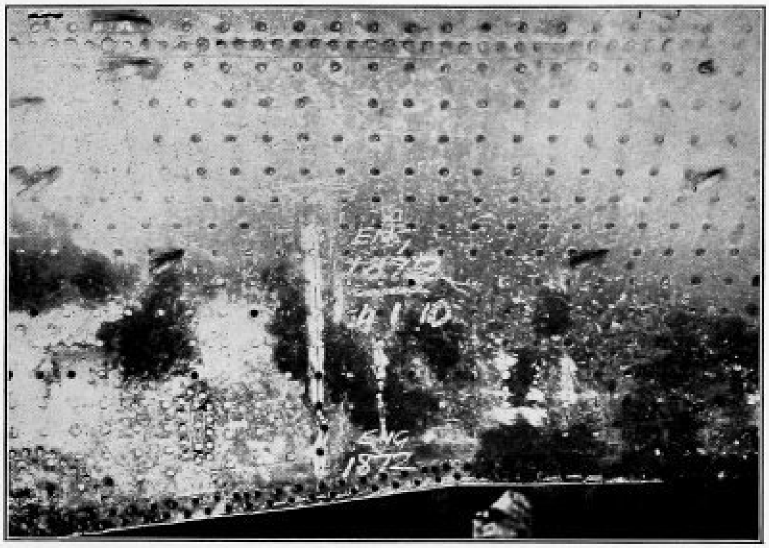


FIG. 2.—FAILURE OF SIDE SHEETS BY CRACKING VERTICALLY, ATTRIBUTED TO THE SAME STRESSES AS THOSE THAT CAUSE THE BACK-HEAD AND THROAT-SHEET FAILURES.

To relieve the cracking of side and back sheets and back flue sheets in wide fireboxes, flexible staybolts were applied as shown in Fig. 7. Satisfactory results have been obtained with this arrangement on both the New York Central and Michigan Central. A full installation in the throat sheet, set loose as follows, is also advisable:

First row above mud ring	Tight
Second row above mud ring	1/32-in. loose
All others	1/16-in. loose.
And the back flue-sheet braces	3/32-in. loose

This will increase the life of a modern fire-box from 50 percent to 75 percent; the loose installation of flexible staybolts in the throat sheet and slack braces to back flue sheet being considered necessary in order to avoid excessive staybolt and flue-sheet breakages, at the same time reducing the strain on the arch-flue anchorages, the latter being quite a source of trouble when they begin to blow, especially at the front end.

In January, 1907, the firebox of an Atlantic type locomotive in heavy passenger service was given a complete equipment of flexible staybolts, including the radial stays. It was the intention to have made this firebox of one piece, but, owing to a defect in one of the side sheets, a half side sheet had to be applied; up to February 1 of this year, at which time the last examination was made, the engine had made 243,000 miles without one broken staybolt, without any vertical cracks in the side sheets, without any trace of a crack in the back head or throat sheet, and without any cracks, or any sign of a crack, leading away from the arch tube holes in the back flue sheet, nor has there ever been a tool on the side

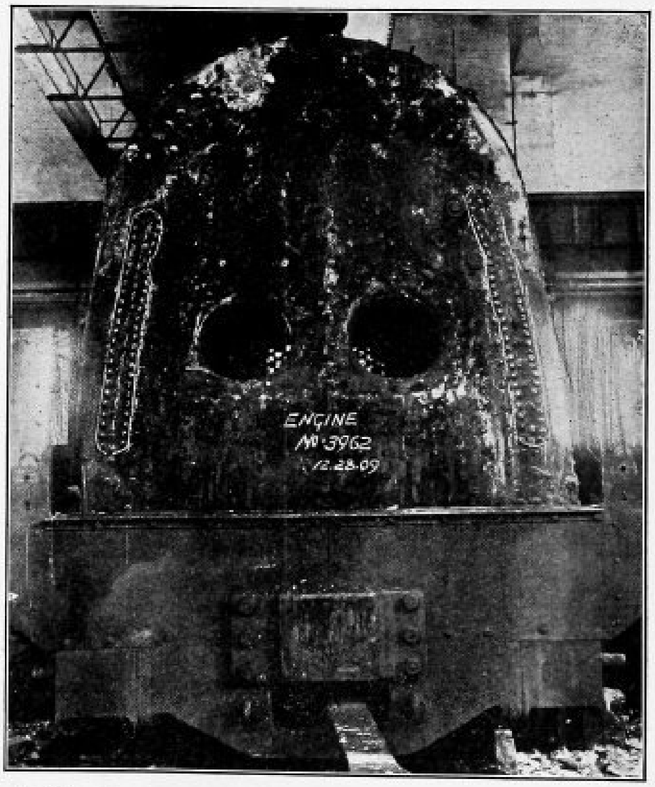


FIG. 3.—FAILURE OF BACK-HEAD ALONG THE OUTER ROW OF STAYBOLT HOLES, A COMMON FAILURE WITH RIGID STAYBOLT SETTING.

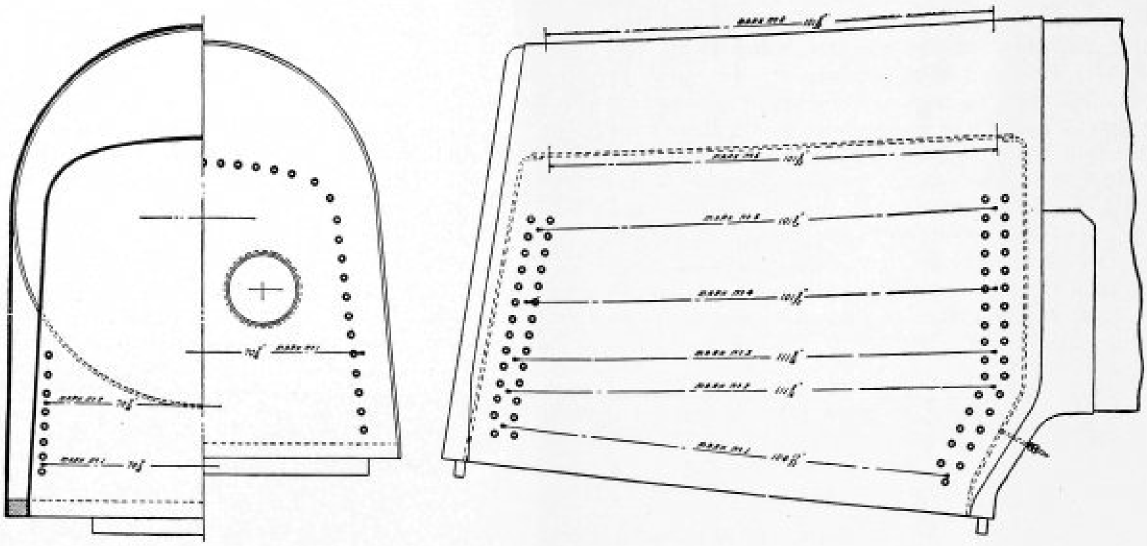


FIG. 4.—LOCATION OF TRAM MARKS TO DETERMINE DIFFERENCE IN EXPANSION BETWEEN INNER AND OUTER FIREBOX SHEETS.

with the circulation good, the expansion in the boiler proper (between the flue sheets) was greater than that in the flues. The results of this test were rather remarkable. The standard gage flue on the New York Central is No. 11 B. W. G., and for this test No. 13 B. W. G. was used. One-half of the flues—those designated by the double ring in Fig. 5—were safe-ended with No. 11 B. W. G. and the other half were not safe-ended. The setting was according to standard practice, with the following exception: Mr. Linderman, supervisor of boilers, personally supervised the job, and each flue, before it was stuck at each end, was depressed at the center 1 5/16 in., Mr. Linderman personally doing the depressing and, at a signal from him, the man at each end stuck the flue in the sheet and expanded it. The whole set of flues (382) was applied in this way, and as a result they had a sag of about 1 in. more than normal when the job was completed.

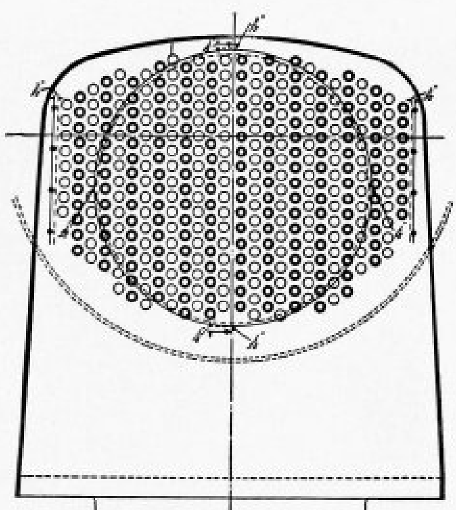


FIG. 5.—EXPANSION OF TUBE SHEET DUE TO PROSSERING.

A needle was attached to one of the top flues at the center and extended up through the shell, as shown in Fig. 8. It was attached to a recording device to show what, if any, movement took place under the various conditions of service from the time the fire was started in the box until the completion of a trip on the road. Fig. 9 shows the movement of the tube, to which the needle was attached, from the time the fire was started until 200 lbs. pressure was raised. Almost immediately after the fire was started the needle began to pull downward, and continued in that direction fully ⅛ in., and remained practically stationary for a few moments; then it began to rise and continued in that direction until about ⅛ in. above the normal position, at which point the steam pressure began to rise, and the rise of the needle from that point up to 175 lbs. pressure was gradual; from 175 lbs. to 200 lbs. it was rapid, with the result that the total rise of the needle above the normal line was 15/16 in. The rapid rise of the needle between the time the pressure increased from 175 lbs. to 200 lbs. cannot be accounted for, unless it did not work in the stuffing box quite as freely as it should; however, the packing in the stuffing box around the needle was very loose.

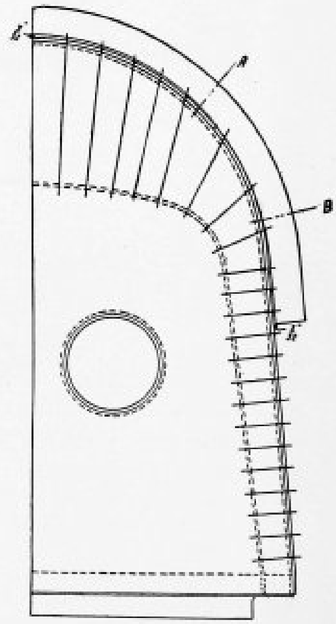


FIG. 6.—LOCATION OF TEMPLATE ON WAGON TOP.

Arrangements were then made to make a road test, and the record is shown in Fig. 10. It will be noted that, immediately upon starting out, the needle began to pull downward, as shown by the solid lines; the dotted lines being the record

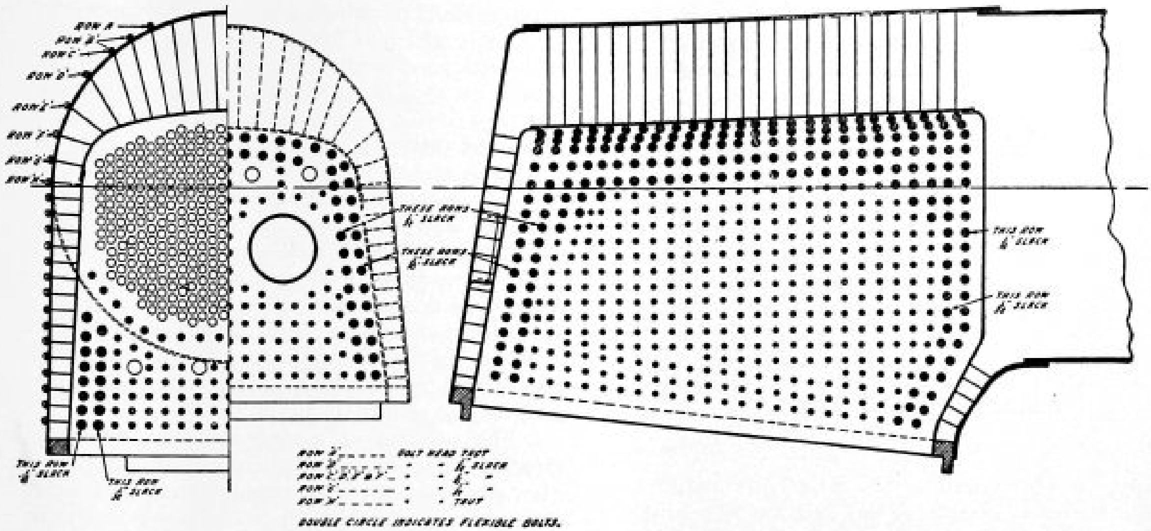


FIG. 7.—ARRANGEMENT OF FLEXIBLE STAYBOLTS, WHICH ELIMINATED FIREBOX FAILURES.

made after the throttle was closed and while drifting. The maximum downward pull on the needle was 3/16 in., this point having been reached while the engine was being worked hard and running at good speed.

This engine was afterward put into regular serivce on heavy passenger trains, and at the same time another engine of exactly the same class, having a set of the standard No. 11 B. W. G. flues, set to correspond with standard practice, was put on in the same service; an accurate record of the cost of maintenance was kept of both. The engine with the special flues and special setting, in making 69,856 miles, never failed, while the engine with standard flues and standard setting, in making 71,774 miles, had a few detentions charged to it on

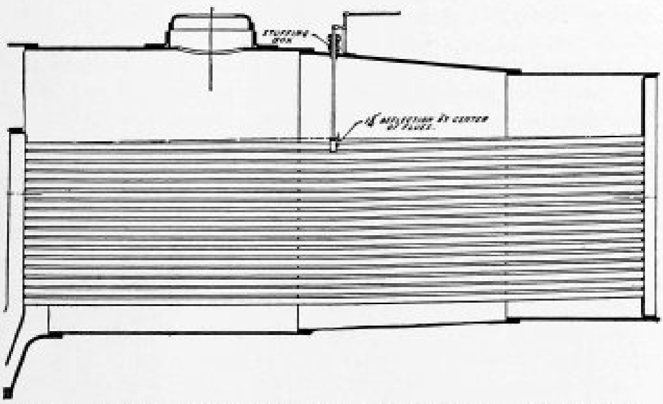


FIG. 8.—ARRANGEMENT OF FLUES TO DETERMINE DIFFERENCE IN EXPANSION BETWEEN THEM AND BOILER SHELL.

account of "flues leaking." The cost of maintenance of both engines is as follows:

Special flues and special settings: Cost per mile for flue work at engines houses.................. $0.0143
Standard flues and standard settings: Cost per mile for flue work at engine houses................ .0195
Percentage in favor of special setting............26.7 percent.

At the time these figures were made up there was no perceptible difference in the condition of the flues in the firebox of either engine, and the No. 13 beads seem to have stood the working as well as the No. 11 beads, which is believed to have been due to the fact that the No. 13 beads did not leak as often as did the No. 11 beads, and therefore did not require to be worked as much.

Ontario Boiler Law Respecting Steam Boilers.

The following are the provisions of the Ontario Boiler Act Respecting Steam Boilers, passed at the recent session of the Ontario Legislature. The bill was a much needed one, and the

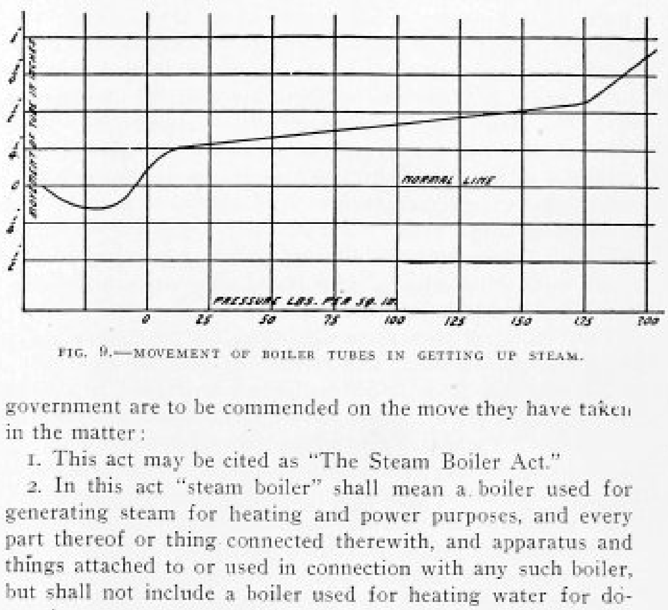


FIG. 9.—MOVEMENT OF BOILER TUBES IN GETTING UP STEAM.

government are to be commended on the move they have taken in the matter:

1. This act may be cited as "The Steam Boiler Act."

2. In this act "steam boiler" shall mean a boiler used for generating steam for heating and power purposes, and every part thereof or thing connected therewith, and apparatus and things attached to or used in connection with any such boiler, but shall not include a boiler used for heating water for domestic purposes or a railway locomotive or steamboat boiler.

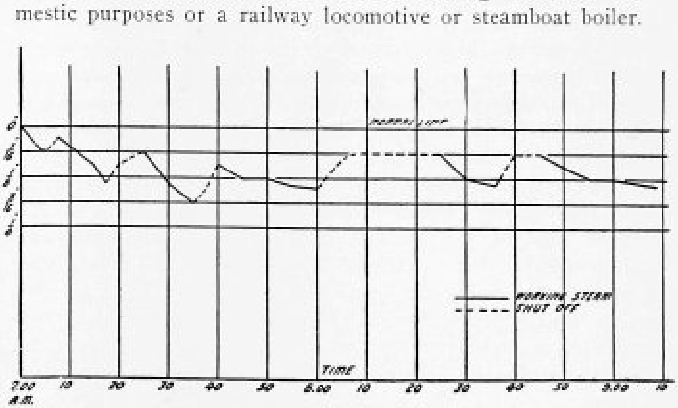


FIG. 10.—MOVEMENT OF TUBES IN ROAD SERVICE, WEST ALBANY TO ROTTERDAM CITY.

3. Upon the recommendation of the Minister of Public Works the Lieutenant-Governor-in-Council may make such rules, regulations and specifications as may be deemed proper respecting the construction of steam boilers, including the materials to be used, the method of construction, the tests to be applied, the inspection of the boiler during its construction and before it is permitted to leave the place of construction, and generally such other matters as may secure a uniform standard of strength, safety and efficiency.

4. The rules, regulations and specifications shall be published in the Ontario *Gazette*, and shall come into force and take effect at a date to be named by proclamation.

THE APPRENTICESHIP SYSTEM OF THE NEW YORK CENTRAL LINES.*

BY C. W. CROSS.

The apprenticeship system of the New York Central lines, which it is desired to describe at this time, has been in operation, and after four years' experience we feel justified in making the statement that it has safely passed the experimental period and has become a regular part of the operation of the railroads comprising the system known as the New York Central Lines.

This apprenticeship system includes special shop instruction carried on in the regular shop, with the boy under actual shop conditions and shop discipline and shop environment. Combined with this training he is obliged to attend educational classes during working hours. In these classes the course of study is intensely practical in character and illustrates, explains and supplements the work in the shop by simple and direct methods suited to the needs of the apprentice. The entire plan is arranged for the beginner, who must start at the bottom. It is one designed to increase the efficiency of the rank and file of mechanics, though it is expected that exceptionally bright boys will profit most by the training offered. From this class will come the necessary leaders. These plans are directed toward a broad and well-constructed foundation of intelligent, thoughtful shop workmen; the genius is left to reveal himself.

I do not agree with those who count out apprenticeship as a means of recruiting the mechanical trades. The things pertaining to a shop can naturally be best learned in a shop. There is no better way of learning to do a thing than by doing it. No school can take the place of practical training in a shop or factory; the best place to learn business is where business is carried on. It is vital that principles be taught with processes and illustrated by them, for the boy who understands the principles underlying a given process will be the most likely to rise to a position of importance in the business. While there are some trades that can be learned entirely at a trade school, there are others of which only a part can be learned at school, and still others which from their nature must be entirely learned in the regular shop. There is ample proof of the fact that mechanical trades can be taught to entire satisfaction at present in the United States by a system of modern apprenticeship.

The apprenticeship system of the New York Central Lines is based largely on the general principles laid down by Mr. G. M. Basford, the practical details of which have been carefully worked up by the Apprentice Department. The system was installed under the general direction of Mr. J. F. Deems, Gen. Supt. Motive Power. In brief, the organization consists of a superintendent of apprentices and his assistant, who have charge of the work and laying out of the educational courses. At each large shop on the system is a drawing instructor who has charge of the educational work; each apprentice spends four hours a week in the classroom, where mathematics and mechanical drawing are taught. The apprentices in the shop are in charge of a shop instructor, who sees that they receive the proper instruction in the trade at their work, and that they are moved from one class of work to another at regular intervals.

The Department of Apprenticeship on the New York Central lines now has under its charge about 700 apprentices located at 10 shops in widely separated locations, but working in harmony with the central organization. The general features of this plan of apprenticeship are equally applicable to any manufacturing organization or factory employing workmen in mechanical trades. In the inauguration of a plan of apprenticeship of the nature referred to, the following features are essential:

1. The selection of a shop instructor employed in some capacity at the shop in question, who is preferably an up-to-date, all-around machinist, competent to give direct instruction in the machinist trade, but with sufficient knowledge of other trades which may have local apprentices to be able to intelligently supervise apprentices in those trades.

2. The selection of a drawing instructor, preferably a draftsman or mechanical engineer, who possesses the real qualifications necessary to successfully instruct ungraded classes under new and trying conditions.

3. To obtain and equip a suitable classroom, located near the centre of the shop property.

4. To secure the hearty co-operation of the shop superintendent, shop foremen, gang bosses and mechanics who have been trained under a different system, and whose co-operation is essential to make such an apprentice system a success.

5. To obtain from the average apprentice a proper appreciation of the opportunities offered, and an enthusiastic endeavor to make the most of them.

6. To introduce the training system for apprentices in a manner that will not interfere with the operation of the shops.

The work in the drawing and shop problems is outlined at the apprentice headquarters at New York City, and sufficient flexibility is allowed to fit the personality of the local instructor and the needs of the local apprentices. The plan of instruction is arranged to give the closest possible connection between the work in the shop and the work in the classroom. In fact, the practical and theoretical parts of the work are so thoroughly united that the grease of the shop is literally rubbed into the lesson sheets and drawing papers. Subjects are not classified, as in most school systems, but the necessary mathematics, mechanics, physics, chemistry, etc., are introduced only as needed to solve some practical shop problem.

The drawing is from actual parts from the start, omitting all exercises and preliminary work as such and introducing principles only as needed to gain practical ends. Simple blue print sketches are used in connection with the actual machine parts. Printed sheets are supplied for the problems.

The shop instructors co-operate with the drawing instructors in looking after the general welfare of the boys.

The instruction is largely individual with classes limited to 24 apprentices at one time. By use of blue print sketches, on which are the necessary directions, it is feasible for the instructor to handle a larger number of students than would be possible without this plan.

The first drawings are very simple, so that accuracy may be insisted upon from the start. The work is scaled so that it cannot be copied from the sketch, and the course is arranged to advance more slowly than usual drawing courses. One principle is introduced at a time and then only as needed to make an actual car or locomotive drawing. Lettering is an incidental item.

* From an address delivered before the International Master Boiler Makers' Association, May, 1910.

The shop problems are worked at home on standard sheets and a careful blackboard review is given in class. The home work is done on loose printed sheets, which makes it possible for an apprentice to go as rapidly as he desires.

All the work that is introduced is in accordance with the New York Central Lines practice, from which illustrations are selected. A comprehensive system of reports is made by both instructors to the local shop officer. These reports show first the ability at the trade, second the disposition and ability of the apprentice, and third the standing in class work. Instructors are at all times required to know the standing of each apprentice, thus making examinations unnecessary. Special emphasis is placed on the personal touch maintained between the instructor and the apprentices with a view to ascertaining the type of work or branch of service for which each boy is best fitted. It has been found necessary to use great care in selecting instructors who must be men who are not only competent, but who are willing to undertake the work for the love of it and their interest in the young men, as well as for the remuneration they receive. At the expiration of apprenticeship those who have satisfactorily completed their term receive certificates which entitle them to preference in employment at all shops on the New York Central Lines.

Instruction is given each apprentice four hours a week during shop time—that is, two mornings from 7 to 9 o'clock, and such instruction is classed under the heading of mechanical drawing. Apprentices ring in before going to class and are under shop discipline during the session. At 9 o'clock they proceed directly to the shop. Home work is required on the problems.

A unique feature of this apprenticeship system is the individual factor. No attempt is made to group the apprentices in classes, but rather to advance each one as much as possible, taking into consideration the personal characteristics and educational foundation as well as the physical qualifications of the apprentices. We make an effort to teach the student concentration of mind, realizing that many of the boys who come to us as apprentices have not had discipline of this kind. If we can teach boys how to study as a first requisite, their progress will be much more satisfactory to themselves and others. It is said that an educated person is one who knows how to use his mind. With this fact in view we make an earnest effort to develop in the young men the habit of study. Our object is to have a light crop over a large area rather than a phenomenal development of a few plants. The effect upon the apprentices has been awakened interest and marked improvement in the school, in the shop, ability to read drawings, ability to layout templates, and, in a number of cases, skill in drafting sufficient to warrant assignment to drafting rooms on the lines.

No more interesting study has presented itself than the personality of the average apprentice. On the whole, he is below the standard of education and ambition generally presumed by most officers, who naturally think all apprentices should possess the same exceptional initiative and earnest endeavor which has brought them up from the ranks. The average apprentice possesses a good deal of human nature; he means well, intends to make the most of his opportunity, but generally prefers to be a real boy and enjoy life rather than to work problems at home. He will not read a text book except under compulsion, and has absorbed a little of the idea that the easiest way to become a journeyman is to do as little work as possible. We do not believe a boy should be considered a hopeless criminal and thrown into jail for these things, as on the whole the interest of the apprentice is good and is increasing in proportion as the facilities for experimental work are increased and the plan of instruction is extended. There are instances where the boys have kept the local instructors busy in supplying them with work, and it is evident that the ambition of many boys has been aroused and that the right chord has been struck, so that in time a boy without ambition will become a rare article. It might also be interesting to state that at nearly all points there are advanced apprentices who take full charge of the class when the instructors are absent.

Perhaps as vital as any other principle is the necessity of caring for graduates with infinite pains after they have completed their apprentice term. The results of the best possible apprentice instruction may be absolutely nullified if the organization into which the graduates are to go is not properly prepared to receive them. It is not too much to say that most railroads and most large industrial establishments need to be organized in such a way as will render employment not only desirable, but development possible.

When we consider that if we take in strangers as journeymen mechanics and give them the maximum rate and refuse to give a graduate apprentice the same consideration, that we are making a distinction that is absolutely unwarranted.

It is not expected that all boys will attain a degree of efficiency that will qualify them for leadership, or that all workmen will possess the same measure of ability and activity on account of the difference in their natural intellectual and physical make-up, but it is expected that each will be developed to a high degree in his particular line, with the result that eventually a shop will be manned by a force of mechanics embodying an advanced state of proficiency from which at least a few competent men may be had at all times for positions of leadership.

The question has been asked, "Is it worth while?" to which we reply, unreservedly, "That it surely is." Graduate apprentices are being furnished for important positions in drawing-rooms and shops as well as recruiting the service with skilled mechanics.

The impression seems to prevail that the New York Central Lines is educating apprentices for other roads, and the statement was to some extent true for a time. However, the recent awakening of interest in industrial education and the inquiries and observations from all directions indicate that other railroads and manufacturing establishments are now giving this matter the consideration it deserves, and in some instances have taken action with a view to inaugurating some part of the plan proposed. The fact is being demonstrated that no outside system of instruction such as trade schools, correspondence schools or even the Y. M. C. A. can fully meet the needs of apprentices, and that the control and direction of the instruction must be coincident with the control and direction of the shop. Indications point to the day not far distant when each railroad will have a fully equipped apprentice system organized as an integral part of its motive power department. Before such a movement can start the management must be convinced that for its own welfare in the future it must be provided with skilled, intelligent, native workmen trained in its own shops, men who can stand on their own merits and do the work which is needed to keep this country commercially ahead of the world; men who will command the respect of their employers; men who can and will bring skill and judgment to their work, so that they may command compensation commensurate with the increased ability.

The United States Steel Corporation has established a pension fund of $8,000,000, which is to be consolidated with the $4,000,000 fund created by Andrew Carnegie several years ago, and the whole used as a fund to provide for the payment of pensions to disabled or superannuated employees of the corporation. The fund will be known as "The United States Steel and Carnegie Pension Fund."

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION.

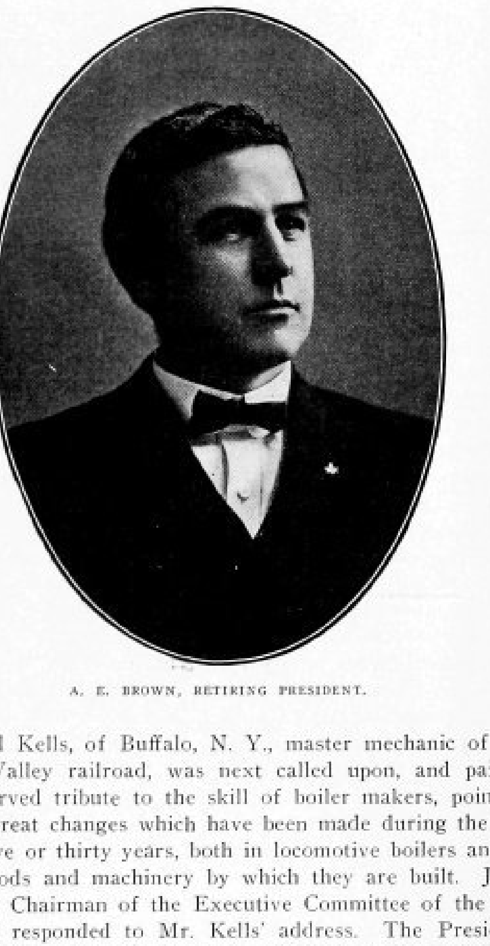
Proceedings of the Fourth Annual Convention at Niagara Falls, Ont., Canada.

The fourth annual convention of the International Master Boiler Makers' Association was held at the New Clifton Hotel, Niagara Falls, Ontario, Canada, May 24, 25, 26 and 27. The convention was called to order at eleven o'clock, Tuesday, May 24, by the President, Arthur E. Brown, and prayer was offered by the Very Reverend Dean Houston, D. C. L., rector of Christ Church, Niagara Falls.

The Association was welcomed to the city by Honorable C. E. Dores, Mayor of the city. A. N. Lucas, First Vice-President of the Association, responded briefly to the Mayor's address, after which the President introduced Mr. C. W. Cross of New York, superintendent of apprentices of the New York Central & Hudson River railroad.

(An abstract of Mr. Cross' address is published on page 162.)

In replying to Mr. Cross's address W. H. Laughridge urged the Association to take up the subject of apprenticeship and discuss it thoroughly.



A. E. BROWN, RETIRING PRESIDENT.

Willard Kells, of Buffalo, N. Y., master mechanic of the Lehigh Valley railroad, was next called upon, and paid a well-deserved tribute to the skill of boiler makers, pointing out the great changes which have been made during the last twenty-five or thirty years, both in locomotive boilers and in the methods and machinery by which they are built. J. T. Goodwin, Chairman of the Executive Committee of the Association, responded to Mr. Kells' address. The President then introduced Col. E. D. Meier, President of the American Boiler Manufacturers' Association.

ABSTRACT OF COL. MEIER'S ADDRESS.

When I was master mechanic of a western road, we had no separate organization for the boilers; but the shop foreman was expected to understand boiler work as well as machine work. We did not have many tools and the difference between the work then and now appeals to me very strongly. I notice a great deal of stress is laid now on flexible staybolts. In the old days our troubles were of a different nature. But I see now we were just about at the turning point where the staybolt troubles were to begin. Our trouble then was with the sheets themselves. Five sixteenths was all we expected in a fire-box. In the old days we had no copper smiths, we had no copper fire-boxes nor copper tubes. I remember Sam Hayes being at one of our conventions and bringing a tube-sheet of his fire-box made with ¾ inch copper. It had been worn down to one-sixteenth of an inch between the staybolts. I had a sad experience with the Lowmoor iron that was then considered by many the best iron we could get for locomotives. I remember being called in and he showed many cracks in the side sheets of the furnace. He took a hammer and gave it a smart blow and a large piece flew right out. I could count from 16 to 18 laminations near the top, separated by layers of cinders. I concluded what we wanted was steel but we didn't want cinders in there because the transfer of heat would go at a certain rate through the iron and it would be stopped by the cinders. The steel was of the very best quality. It was crucible steel. This was before the days of Bessemer or open-hearth steel and it was made in Pittsburg, in crucibles. The great success of Krupp was also made with crucible steel. And the success was dependent on the greatest discipline by which he was enabled to take forty or fifty crucibles and cast them together into one mold. That brings up reflections of what we must have in our shops in order that our labor shall result in the success which it deserves.

In these days, everything goes by organization and the individual sinks out of sight in his contention with the great aggregations of other individuals who may have intentions and interests which may be to some extent antagonistic to his own. Therefore such an organization as you have formed is very necessary. My association, the American Boiler Manufacturers' Association of the United States and Canada was formed from just that necessity. If we had not done it the steel men, the tube men and others would have pulled the wool over our eyes, You know when one of these supply men comes to see you, if you sit down and let him talk, he will easily persuade you that green is red. You have to assert yourself. You feel when you come in contact with this individual that you need some assistance. And your organization affords that assistance. We must have quality both in the material and in the workmanship. One of the first things leading up in that direction was the establishment of specifications for material. Every year there have been some modifications to make them more perfect. We wrote the first specifications in 1889. In 1892 I presented to the association a series of tests representing some 255 different shipments of boiler plate and every one of them was better than our specifications. All that is necessary is to specify to the American Manufacturing Association what you want and they have the competition between them and the pride in their worth which will induce them to do better than you ask.

It has now become very necessary to insist on rigid specifications not only in the matter of materials, but also in the workmanship. We have gone from thinner to heavier plate in all our work. The demands of commerce in this great country have been such that we are building larger and heavier locomotives than anywhere else in the world; and you gentlemen are the men that have got to give us this power. It all depends on you. An appeal is made to you to devise better means of fastening your tubes. You must get from the tube men the best they can produce. Metal that will stand any amount of bending and changes in temperature and pressure. You have got to get the discipline among the men in your shop so that they will do exactly what you tell them. That is where the German nation has surged ahead of every nation in Europe on account of the perfect discipline they have in their shops. What we want in the railway system is the same kind of loyalty from every man in it from the man who sweeps the floor to the master mechanic, that you exepect from the soldier in the ranks. If we are in a shop then we must show to our foreman and master mechanic that same spirit of loyalty. If we do not do that we cannot win; but if we stand together and insist on quality in materials and in workmanship, and in devotion to duty we will always remain what we are now, the foremost industrial nation in the world.

George Wagstaff responded to Col. Meier. Mr. Wagstaff attended the last convention of the Boiler Manufacturers' Association as a delegate of the International Master Boiler Makers' Association, and expressed to the Association his appreciation of the cordial reception which he received, and the many courtesies extended to him.

The next address was delivered by George L. Fowler of the staff of the *Railway Age Gazette*. Mr. Fowler called attention to the bill pending before Congress regarding locomotive boiler inspection, pointing out that few boiler explosions have occurred due to faulty material or workmanship. He stated that it is not so much a question of inspection of boilers as it is a question of who operates them. Mr. Conrath, former President of the Association, responded to Mr. Fowler. The President then addressed the convention as follows:

ABSTRACT OF PRESIDENT'S ADDRESS.

We are assembled for mutual counsel, and much can be accomplished by the individual members of the Association by honest endeavor and earnest effort as the growth of our Association has exemplified. There is work for us all and strict adherence to established rules and formulas should be the guiding principle of boiler making, and we should never deviate from their well-tried usages.

Of all the important matters that require our never-ending energy is an immediate shop organization. One's accomplishments as to theory and practice in boiler construction may all be destroyed or rendered ineffective unless we are successful in the handling of men; in displaying fairness and just treatment to our subordinates, which in turn will be followed by close application and increased efficiency on their part. I feel it exceedingly just that I admonish you relative to the apprentice under your immediate care; the one who possibly some day may be in charge of the work, carrying it out as you have taught him. What greater source of pleasure and pride can there be to the master boiler maker of today when he reflects upon these same youths who have fathomed these knotty problems and arrived to that point of perfection with credit to himself and to your full and entire approbation? You will thoroughly agree with the speaker that a thought planted in the minds of young men may be a corner-stone to their future usefulness.

In regard to the work and growth of the Association during the past year; it is only proper that we should look the situation squarely in the face, so that we may make greater progress in the future. A better appreciation of the situation may be helpful, so that the members of the Association may be stimulated to greater efforts to bring about the success which we all desire. The Association cannot be said to have stood still during the past year, nor, perhaps has it lost ground, but it certainly has not advanced as it should. Even the most cursory investigation will show that the fault does not lie entirely with your officers. They have been handicapped severely by lack of funds and by lack of the interest on the part of the individual members, which is so necessary to accomplish their work satisfactorily. Individual members are to blame for the lack of progress. If all members in arrears had paid up promptly there would be enough funds in the treasury to carry out our work, and, with the material available for the purpose, there would be a real increase in membership. You are engaged in an art that is the foundation of all motive power. Why not apply some of its principles to the affairs of this Association?

The next order of business was the report of the Secretary. This was followed by the reading of the Treasurer's report, and the remainder of the session was taken up with the appointing of committees and the reading of miscellaneous announcements.

A. N. LUCAS, PRESIDENT.

SECRETARY'S ANNUAL REPORT.

The undersigned begs leave to report that since his last annual report a total of $823.50 has been received and remitted to the treasurer from the following sources:

From dues	$630.00
From initiation fees	93.00
From miscellaneous sources	100.50
	$823.50

MEMBERSHIP RECORD.

Number to be suspended for two years' arrearage of dues		107
Number died during the past year	4	
Number dropped for want of correct address	41	
Number resigned	1	46
		153
Number in good standing at this date, including 13 new members added since the last convention.		236
If to the number in good standing could be added the delinquents (107) the total number of members would be		343

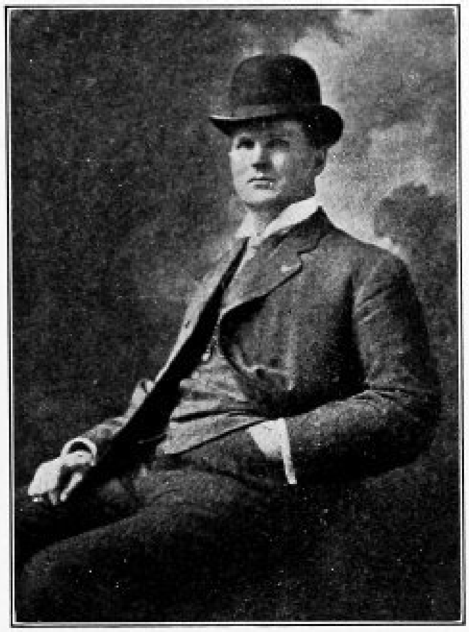
HARRY D. VOIGHT.

STATEMENT FROM TREASURER'S ANNUAL REPORT.

Total receipts	$1,080.19
Total expenditures	867.84
Balance on hand	$212.35

WEDNESDAY MORNING SESSION.

President A. E. Brown called the convention to order at ten thirty o'clock and introduced Mr. D. R. MacBain, Superintendent of Machinery of the Lake Shore Railroad, who expressed pleasure at attending the convention, adding, "I have thought that the formation of the boiler makers into an association was one of the best things that has ever been effected for the railroad. I have watched it from its inception and have tried to help it along where it would be strong and good. I believe that such gatherings as these are the place to bring up these matters. We have stood still, so to speak, in the locomotive boiler world. We have hung on to the old processes too long. We have got to change our methods. We have got to begin and thresh these questions



G. W. BENNETT, FIRST VICE-PRESIDENT.

over and try and see if we cannot get on a better line of procedure than we have at the present time.

The President next introduced Mr. C. H. Hogan, Division Superintendent Motive Power N. Y. C. Lines, Depew, New York.

ABSTRACT OF MR. HOGAN'S ADDRESS.

I want to concur in what Mr. MacBain has said. Also I am pleased to know that you have called upon him to present his paper to you this afternoon, as I know it will be interesting and you will all agree with me when you have heard it that he has started something in the mechanical world, something for all mechancial men to think about—a paper that will assist you greatly in your work of bringing about system, something you have never had. There are other mechanical men. You have not been alone in the mechanical world. Without an efficient boiler, the efficiency of the locomotive is lost. The methods of retaining the boiler have been left entirely to you, but the time has arrived when mechanical men have realized that they must give you their support. It is too serious a matter to meet alone. We learn from one another and by you meeting and agreeing with others you will be better able to meet some of the serious conditions which you have been called upon to meet in the past. Mr. MacBain's paper, which was prepared after long and careful study and contains some of the most interesting ideas and facts that were ever made in this part of the country, is going to put you in the class where you belong. It will show you conditions that must be taken care of in order to get the full efficiency from the boiler. I am glad that the paper will be presented here to-day, because you are the men who are better able to meet these conditions than any class of men I know of.

Mr. Wagstaff responded to the previous speakers.

Report of the Executive Committee.

Your Executive Committee have seen fit to make the following recommendations for your consideration:

Your Executive Committee recommends regarding committee reports on subjects for discussion that the chairman's report and the individual reports sent to the Chairman on the subject be read as found in future, as we regard it very necessary to get individual interest by reading same, and we also recommend that such appear in our annual proceedings.

Your Executive Committee also recommends that the President appoint a membership committee whose duties will be to secure new members and to cancel delinquent dues whenever same is consistent and remit same to the Secretary.

Your Executive Committee recommends that the Association's rules, formulas and by-laws drawn up by the committee on this subject be printed in book form.

The foregoing recommendations were discussed separately, with the result that each was unanimously adopted.

Following this, the report of the Auditing Committee was read and received with thanks.

Report of Committee on the Standardizing of Flanges for Steam Boilers and Templets for Drilling Same.

Your committee on the Standardizing of Pipe Flanges for Steam Boilers and Templets for Drilling same beg leave to report:

, That this subject was fully covered in the report submitted to you at your session at Louisville, Kentucky last year, and printed in our official proceedings. We therefore respectfully refer our members to the report printed therein. A copy of this report is attached thereto, together with the necessary blue prints.

While believing that a uniform standard that would be universally adopted is something to be desired, especially in marine work, yet we consider that this is beyond the scope of our Association at the present time. Your committee therefore, have come to the final conclusion to recommend the adoption of the following:

Cast Iron Pipe Flanges, screwed, as per tables, Fig. 1 and 2.

Forged Steel Pipe Flanges, screwed, as per tables, Fig. 3 and 4.

Forged Steel Pipe Flanges for Riveted Pipe as per tables, Fig. 5 and 6.

Cast Iron Saddle Nozzle as per tables, Fig. 11 and 12.

The above are in our judgment the best or at least as good as any in use at the present time, and have been adopted by the leading manufacturers and societies in the United States and Canada; we therefore respectfully recommend them for adoption.

A committee of three was appointed to check over the recommendations of the committee and report before the close of the Convention.

WEDNESDAY AFTERNOON SESSION.

President A. E. Brown called the Convention to order at 2:45 P. M.

Report of Delegate to Boiler Manufacturers' Convention.

Our delegate was received very kindly by the members of the American Boiler Manufacturers' Association. As the President reported in his annual address, they ordered one hundred copies of our proceedings, which is $100, and they asked permission to send a delegate to our Convention this year. The proceedings of their Convention are contained in their annual report, and I move that this booklet be turned over to the Secretary and the report of that meeting be incorporated in our proceedings. I can assure this Convention that whoever we sent as a delegate to that Association will be kindly received. GEORGE WAGSTAFF.

The motion was unanimously carried.

What Radical Departures are Being Made in Boilers and Fireboxes.

This is a very broad subject. The committee has endeavored to present as many of the radical changes as possible at this time. Our report is not a compiled report, as I did not think it possible to compile a complete report myself.

The separate reports of the individual members of the committee are therefore presented for your consideration.

B. F. SARVER, Chairman.

REPORT OF J. H. SMYTHE.

Many boilers are patented, but simplicity should govern our inventions. The cracking of firebox sheets suggests making the water space wider, say about 7 inches. Tests were made a few years ago by the Santa Fe Railroad, in which four water gage cocks were placed in the outer sheet at the hottest part of the furnace. The pipe leading from one of these cocks reached to within 1/16 inch of the fire sheet, the pipe from the second one reached to within ⅛ inch of the fire sheet, the third to within ¼ inch of the fire sheet, and the fourth to within ⅜ inch of the fire sheet. When the locomotive was working hard, it was found that dry steam issued from the gage cock reaching to within 1/16 inch of the fire sheet, wet steam was obtained from that reaching to within ⅛ inch and water from the others.

I believe that either the O'Connor patent fire door sheet or the Woods corrugated door will largely overcome the cracking around fire door holes.

There is no question about the value of flexible staybolts as a means for stopping staybolt breakage.

I also believe in scarfing flanges from the mud-ring up 36 inches, making the edges of the flange ¼ inch thick, increasing to the full thickness of the plate at the rivet. This saves the flanges from cracking.

There does not seem to me to be any advantage in drilling holes over punching them ⅛ inch small and reaming them out.

The practice followed on the New York Central Lines of reducing flues to 1 11/16 inches for a distance 4 inches back from the back flue sheet tends to overcome flue trouble by widening the bridges between flues and keeping the flues clean, due to the greater velocity of gases through the ends.

I believe we will have to come back to the narrow or ogee boiler to overcome the bulging of side sheets.

Better circulation could be obtained by placing the feed checks on top of the boiler instead of at the sides, so that the feed water is heated by the steam in the boiler before it reaches the water legs.

ABSTRACT OF REPORT BY F. A. MAYER.

The broad firebox, originally designed to burn inferior fuel, is now found essential in all heavier types of locomotives, as it gives larger grate area without undue length. A new design of the wide firebox provides legs nearly vertical to give free circulation. The water leg is widened at the top and by making the sheets practically vertical the down-current of cold water does not interfere with the up-current of hot water.

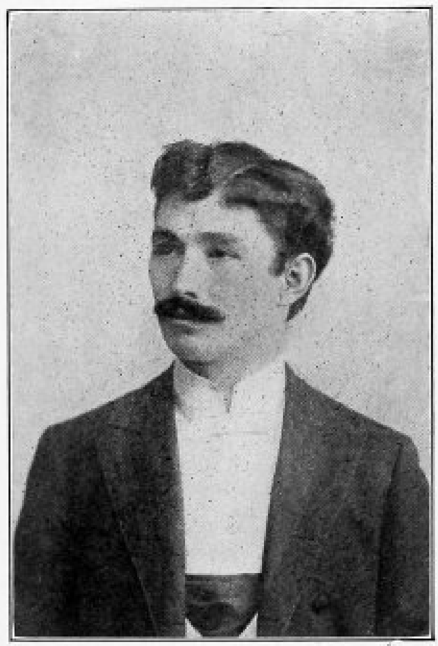
To meet the requirements of boilers of large diamter, carrying steam at high pressure, diamond welt straps are used for riveted joints. These give as high as 95 percent efficiency. To increase the strength of the joints at the ends of the seam the plates are welded in a special furnace.

Boilers for Mallet locomotives are built in two sections with two sets of tubes with a combustion chamber between the two sections. This construction is designed to overcome the use of excessively long tubes.

Flexible staybolts are recommended as the best means of preventing staybolt breakage.

The American Locomotive Company is now building locomotives with flues from 22 to 24 feet long. This company also uses the Cour-Castle corrugated side sheets to some extent. These sheets have vertical corrugations between each row of staybolts. They also use the O'Connor door sheet. A number of boilers have recently been built with combustion chambers from 3 to 6 feet in length.

Superheating probably offers more advantages in boiler construction than anything elese in recent years. Superheaters of the Cole side header type are used by the American Locomotive Company for superheating to moderate temperatures. For highly superheated steam they recommend a double loop system in which the steam traverses the superheater pipes four times. Some attention is also being given to feed water heaters, ecpecially with Mallet locomotives.



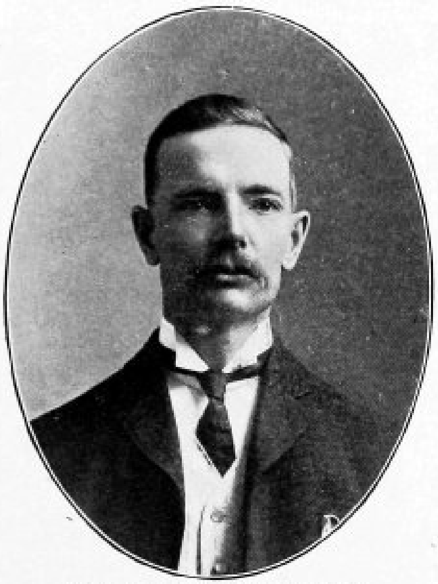
J. W. KELLY, SECOND VICE-PRESIDENT.

THE JACOBS-SHUPERT FIREBOX.

This report briefly described the Jacobs-Shupert firebox, a complete description of which was published in the April, 1909, issue of THE BOILER MAKER. It was pointed out that the advantages of this firebox are unusual safety, freedom for expansion and contraction, improved vertical circulation, the acceleration of the scrubbing effect of the hot gases on the firebox heating surfaces and an increase in the heating surface. It was stated that a firebox of this type has been in service since April, 1909, on a freight locomotive of the heaviest type operated on a single set of drivers on the Santa Fe railroad, and that in spite of the severe service which this engine encounters, due to steep grades, sharp curves and bad water, the firebox has developed no leaks or other failures up to the present time. This type of firebox is claimed to have increased the evaporation per square foot of heating surface 35 percent and to have decreased the fuel consumption per ton hauled 12 percent. It is now being applied to a large number of the heaviest type of Mallet locomotives under construction at the Baldwin Locomotive Works.

A REINFORCING FLUE SHEET.

This report was presented by Mr. J. A. Doarnberger and described a reinforcing flue sheet which he has patented and applied to one hundred and seventy-nine engines on the Norfolk & Western Railway. For a complete description of this flue sheet we refer our readers to the November, 1908, issue of THE BOILER MAKER. Mr. Doarnberger stated that leaky flues are due to three causes, contraction and expansion, vibration of the tubes and the attack of the hot gases impinging on the ends of the tubes. Briefly, his device consists of a second flue sheet placed forward of the back flue sheet. The reinforcing sheet is of 5/8 inch material, while the back flue sheet is of 3/8 inch plate. The two sheets are thoroughly stayed together by staybolts. It is claimed that the reinforcing sheet braces the back flue sheet, provides better circulation by forming a channel in front of the flue sheet, and provides a means of readily safe-ending the tubes in place. With



T. W. LOWE, THIRD VICE-PRESIDENT.

this sheet it is only necessary to roll the flues in the back flue sheet and not bead them. It is not necessary to shop a locomotive for flue work, and the short flues can be renewed at about one-half the cost of renewing ordinary flues. The cost of applying this device to a boiler was given as $37.63, and the cost of renewing and resetting the short flues as 8 cents.

ABSTRACT OF REPORT BY A. N. LUCAS.

The Jacobs-Shupert boiler is one of the most radical departures in locomotive boiler construction, but a period of some five or six years must elapse before the good or bad qualities of this boiler will be developed.

We get better results from wide fire-boxes when they are built on the horseshoe plan, where they are narrower at the bottom than at the top. We have had 100 of these in service during the last thirty months and the side sheets are in good condition and there has been no trouble from stay-bolts leaking.

Our new passenger engines are built with combustion chambers. We have 215 of these in service and 25 more under construction. No trouble has been experienced with the combustion chambers to date. We have very little flue trouble with them and have not had occasion to renew any flues whatever.

ABSTRACT OF REPORT BY B. F. SARVER.

Mr. Sarver, as chairman of the committee on the above topic, concurred in the reports from the other members of the committee, and, in addition, submitted two other very important matters which have been developed and found successful. The first was a complete installation of flexible stay-bolts. He stated that, in his opinion, this has been one of the most important developments, and has done as much good as any other change. Complete installations of flexible stay-bolts have saved fire-boxes, have reduced the great number of broken stay-bolts, and have also reduced the cost of maintenance of boilers. The second recommendation which he made was the adoption of steel for flues and safe-ends. This was recommended because of the following advantages: Very much increased flue mileage, decreased cost of steel flues over iron flues and decreased cost of maintenance.

Discussion of the foregoing reports was postponed until the following day. The President then introduced Mr. D. R. McBain, who gave a stereopticon lecture on the inequality of expansion in locomotive boilers and the possibility of eliminating the bad effects therefrom. This address was first given before the May meeting of the New York Railroad Club, and was published in the proceedings of the Club. An abstract of the address appears on page 158.

The Convention extended a rising vote of thanks to Mr. McBain for his very interesting and instructive lecture.

THURSDAY AFTERNOON SESSION.

The convention was called to order at 2:30 o'clock, and it was voted that the association receive the paper read by Mr. McBain and ask permission of the New York Railroad Club for publication of same in the annual proceedings.

Standardizing Shop Tools and Machinery.

Owing to the lateness of the appointment of the committee on this subject, no detailed report could be given. It was recommended, however, that the subject be continued for another year and careful consideration be given it. The committee commended the report presented at the 1909 convention on this topic.

The report of the committee was accepted and it was moved to continue the subject for another year.

Discussion of Report on What Radical Departures Are Being Made in Boilers and Fire-Boxes.

C. L. Hempel.—The only radical departure in the past two or three years is the Jacobs-Shupert and the Woods corrugated firebox. The other designs are practically old designs. The Jacobs-Shupert fire-box is possibly two years old, and at the present time we do not know just what service these engines are giving. The New York Central has in service some three or four of the Wood fire-boxes. On the Union Pacific we have one that has been recently applied.

I have some criticism in regard to the Wood fire-box. I believe there is an error in the design of that box, inasmuch as the bolts are in the concave from the water side, instead of in the convex part of the crown sheet and side sheet. It permits a pack between the bolts, preventing the water washing it out. If the bolts were on the convex side you could wash the boilers very easily, and they would give good service. It strikes me that the principle involved in the Wood firebox is the only scientific principle that we have encountered up to the present time. In all metals that expand it is necessary to put in a "U" to provide for the expansion. By corrugating the box you put the "U" in the metal on a smaller scale.

The Jacobs fire-box is designed for the same reason. The corrugations are there in the shape of a channel. It is possible they are giving the same service as the Wood box is giving. I am not going to say that I believe the box will give us as good service, but I do believe that it will give us better service than the straight box.

J. T. Johnston.—We have on the Sante Fe five of the Jacobs-

Shupert fire-boxes. I was at Louisville a year ago and was not very enthusiastic over these fire-boxes, but in one year of service of one of our engines, I will state that we have not laid a hammer on that fire-box with the exception of calking the flues. I believe it is the coming fire-box. With the straight fire-box we have been putting in stay-bolts continually in the side sheets, radial stays every year and a half, and also ordinary repairs that you all make in the first year, but on this new fire-box we have not used a hammer nor found a leak up to the present time.

F. A. Linderman.—We have three boilers in service with the Wood fire-box; the first one went into service a year ago last December. We changed the flues in that once. As they are on test I would rather not say much about them. We have had more trouble with these boilers with leaking staybolts than with any others.

Mr. Hempel.—Mr. Linderman's remarks have backed up my criticism. The staybolts are placed in the wrong place. Next year I will give a complete report of what the Wood box is doing on the Union Pacific.

The President.—A year ago I had considerable to say relative to this particular box. I also said a year ago that I had had considerable experience with corrugated boxes. My trouble was cracking vertically at the inner corrugation of the fire-box. The box was corrugated in the simplest form, a waver from the flue sheet to the door sheet on both sides. These corrugations gave us vertical cracks in new fire-boxes from eight to twelve months in service that required patches. This has satisfied me that vertical corrugations in fire-boxes are not the right thing. It would be a hard proposition if we had to apply a patch on any of the corrugations in the Wood fire-box. I thoroughly agree with Mr. Hempel's remarks.

P. J. Conrath.—Some years ago I departed from the regular practice by trying horizontal corrugations. My idea was that the expansion upward would relieve the strain on the bolts and prevent them from leaking. First I got very good results by putting in this corrugation. The round-house boiler makers all agreed that the corrugation prevented the bolts from leaking in the fire side. After they had been in service for about eighteen months they began to crack, and it was impossible to make any repairs to them, and it was necessary to remove the sheets. Where you have bad alkali water and the life of your sheets would be short of two years, it would be a paying proposition to corrugate your sheets. If a straight sheet is going to fail in a couple of years, it becomes a serious question to look into this matter and to try to eliminate this failure. The corrugated sheet prevented the bolts from leaking. The life of the sheet was only eighteen to twenty months, but I spent considerably less for maintenance and for running repairs, and cut out a good many engine failures.

J. T. Kelly.—We have made tests with a straight plate and a corrugated plate. The straight plate gave us trouble and the corrugated plate did not. It is covered by the Castle-Cour design of corrugation. Mr. Wood should not put his bolts in the bottom of his corrugation but on the top.

Mr. Johnston.—We have three Castle-Cour fire-boxes. Two cracked in eight months and nine months, respectively. We had to hammer the stay-bolts so much to keep them tight that they broke. A third of them broke within six to nine months.

A. N. Lucas.—We have had a number of our boilers in a bad-water district, and we have had no trouble with the combustion chambers. Our fire-boxes are on the horseshoe plan—narrower at the bottom than at the top. We seem to get better results with our boilers built on that plan than with the straight sheets.

H. J. Wandberg.—They are the best boilers that we have ever put in service in the bad-water district. I have got as high as eighteen months' service out of some of them. We had little trouble with the stay-bolts, and none at all with the combustion chamber. At the top of the flue sheet I noticed cracks, and have patched two.

The President.—In your experience, Mr. Sarver, do you know of any corrugation in existence on the Pennsylvania lines?

B. F. Sarver.—No, sir; I do not.

G. W. Bennett.—Twenty years ago I had considerable experience with corrugated side sheets. Every side sheet cracks in the corrugation.

M. O'Connor.—On our western district on the Northwestern Railroad we have some bad water, and we were never able to keep our stay-bolts tight with a straight side sheet. They leaked continually, and then the sheet commenced to crack. A few years ago they applied the corrugated side sheets, and we have never had any trouble with side sheets since. We have reduced the expense of cracking side sheets 50 percent, and we have no leaky stay-bolts. We have but very little cracking compared with the straight side sheets.

C. L. Hempel.—Mr. Johnston, of the Sante Fe system, Los Angeles, told you that they had several engines equipped with

J. T. JOHNSTON, FOURTH VICE-PRESIDENT.

side plates of the Cour-Castle style. Mr. O'Connor said they had corrugated side plates and never had any trouble. Mr. Kelly said they had corrugated side plates and very little trouble with stay-bolts leaking. We have had corrugated side plates, and in twenty months we have not touched one tool to these side plates. Some other gentleman said that the side plates cracked in between the rows of stay-bolts. That is true; the side plates will crack, in course of time. But if you can apply a plate that will reduce your repairs 50 percent you have gained something. It is very singular that Mr. Johnston, out on the Coast, will have this trouble, while we in the Central States have no trouble of that kind. I think the stay-bolts should be in the convex part instead of the concave side of the plates.

John McKeown.—Thirty years ago the Pennsylvania Railroad tried to corrugate crown sheets on the Pan Handle. We found trouble with the side plates on the high side next the fire. These plates scaled more than the inner, and also the crown sheet in the low spots was scaled up to 1/4 inch thick. The water was bad; we could not use it.

Mr. Lucas.—We ought not to do any more work on our fire-box plates than is absolutely necessary. If we can make the straight plate go we had better do it. If we can arrange with a flexible stay-bolt, as outlined in the talk by Mr. MacBain yesterday, I think the straight sheet will be all right for me. I have just renewed a fire-box that has been running seventeen years.

B. F. Sarver.—We have had considerable trouble with side sheets leaking. Two years ago we made a full installation of flexible stay-bolts. The engine is in the Fort Wayne shop at the present time, and the side sheets are in as good condition as when we first put them in. I believe that the flexible staybolt will give you as much relief as any other thing you can resort to.

It was voted that the subject be continued for another year.

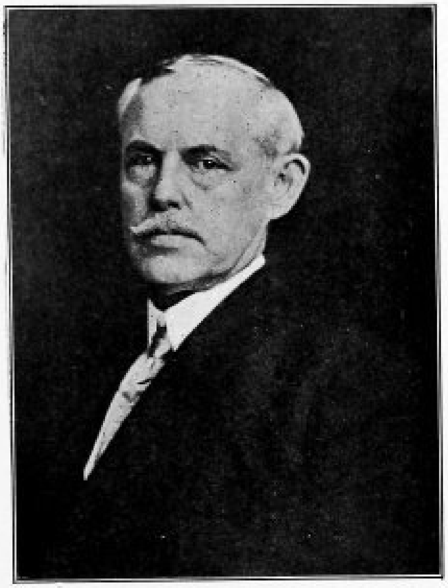
Report of Special Committee Appointed to Check Over Report on Standardization of Pipe Flanges.

The committee recommended that certain blue prints, showing the standard adopted by the American Society of Mechanical Engineers, be adopted by the association, and that other prints, showing different styles of flanges, which were carefully compiled by the committee, and all of which are good, be embodied in the proceedings of the association.

P. J. CONRATH, Chairman.

The report of the committee was accepted as read.

[EDITOR'S NOTE:—The substance of the report of the committee on pipe flanges was published in our June, 1909, issue, and the data, comprising the American Society of Mechanical Engineers' standard, which was recommended for adoption by the above committee, are published elsewhere in this issue.]



HARRY D. VOUGHT, SECRETARY.

To What Extent Do Firebox Door Holes Crack and What is Being Done to Prevent Same.

Cracked door holes are about as common as leaky flues, but not so harmful to the steaming qualities of the engine. The trouble seems to be almost universal regardless of the shape of the hole. Various opinions are brought forward regarding the cause of this cracking, some claiming that it is due to the admission of air while firing, and some that it is due to the abuse of the plates in the construction of the boiler. Probably the former has nothing to do with it, but there is some foundation for the latter opinion. The real cause, however, is the breathing movement of the sheets, due to unequal expansion and contraction. This is clearly indicated by the nature and location of the cracks, as fractures always develop first on the inside knuckle radially with the corners of the hole. There are no radical changes being introduced to prevent this cracking, except in one or two instances. The O'Connor door sheet is an improvement over the ordinary design, as it compensates for vibration. The design with the long nozzle and solid ring between it and the flange in the back head is an old design, which is coming into use again to some extent, and which is giving good results; for it stiffens the plates at the hole and distributes the vibration more uniformly than the O'Connor type of sheet. Any innovation should be along the line of stiffening up this opening in order to overcome the breaking stresses.

Mr. Kelly.—We have been putting in the O'Connor doors for several years, and they have given us fine service.

John German.—I put in one of Mr. O'Connor's doors about eight years ago. There is not a crack in the knuckle of that flange to-day. It has cracked over the inner flange towards the stay-bolt, but not in the knuckle.

A. N. Lucas.—We have applied three of the O'Connor door rings, and they have given us good results. Get your stay-bolts back far enough, and you will have no trouble.

T. W. Lowe.—Is there any difference in the results as to the shape of the door? We have different shaped doors on locomotives, and find that the oval shaped doors fail very rapidly.

A. N. Lucas.—In reply to Mr. Lowe my experience has been that oval doors crack on the sides first. I do not like the oval door. It has too much flat surface on top, and you have trouble due to mud accumulation.

The President.—My experience is with the oval door. They show cracks on the sides mostly and sometimes on the top. I have never tried any of the doors Mr. German speaks of, but the material in flanging is handled very cautiously. It is not struck with the hammer; but we do have those cracks.

W. M. Wilson.—We have a fire-box door hole flat on the bottom, with a small radius on the corner and quite a long radius on top. The fire-door holes crack at the lower part of the door-hole on the side; and in some cases on top, and sometimes all the way round. The sheet is very severely strained by the short radius. Nothing can be done with that shape of door hole, unless the design is changed or a corrugation put in such as the O'Connor door hole. Our practice is to weld in patches. It does not pay to patch them in the old-fashioned way. We devote the money to buying a new door sheet. We have a number of engines running with both sides of the door patched by the acetylene process.

Mr. McKeown.—We had some door holes crack, but it was due to stay-bolts being too close. We overcame that by keeping the stay-bolts further away, and by making the lips shorter and putting a bigger curve around the door.

It was voted that the subject be continued for another year.

Best Method of Staying the Front of the Crown Sheet in Radial Stayed Boilers.

After extensive investigation the committee finds that no method of bracing has yet been designed to entirely eliminate bending and cracking at the top flange of the flue sheet in radial stayed boilers. The primary cause of the bending and cracking is the stretching or lengthening of the flue sheet, coupled with the inelasticity of the crown sheet, which prevents it from readily adjusting itself to the increased length of the flue sheet. The initial cause of the stretching or lengthening of the flue sheet is the abuse of the sheet, due to flue work. However, if the sheet were free to move at the top there would be no bending or consequent cracking of the flange. Increasing the margin above the flues mitigates the evil somewhat but does not eliminate it. It is obvious that the flue sheet receives greater abuse in bad-water districts where there is much flue leakage, whereas in good-water districts very little trouble is experienced.

Where the T-bar arrangement of supporting the front part of the crown sheet is used it has been found that a deflection occurs in the crown sheet of from ¼ inch to ¾ inch at either end of the T bar, which is due to the T bar going down at the ends and the crown sheet coming up just beyond the T bar, the radius of the T bar becoming smaller to such an extent that when a new flue sheet is applied it is necessary to change the radius of the bar. This condition does not exist where the eye-bolt and sling stay, or some other more flexible form of stay, is used.

A modified form of the radial stayed boiler is in use with a flat crown sheet having T bars on the crown and roof sheets connected by braces. The crown sheet has a smaller radius at the stays than is usual, and it is said that these sheets crack in time longitudinally along the bend. The crown bar of the Belpaire boiler is said to be more satisfactory, as far as the upper flange of the flue sheet is concerned. In one instance it was found where the T bar was used that the crown sheets cracked at the ends of the T bar.

In one instance it was found that a 2-inch and 3-inch radius at the top of the back flue sheet on radial stayed boilers does not prevent their cracking, so a ¾-inch radius is used, and is found to give better results.

In another instance it was found that if rigid or radial stays are employed the flue sheet cracks horizontally along the heel of the flange, whereas if any other method of staying is employed the sheet is allowed to move upward, and the flue sheet cracks from the top flue holes up through the flange. It is pointed out that the greater heat at the center of the flue sheet causes the sheet to expand, and since this expansion is resisted in a horizontal direction its full force is expended in a vertical direction, causing the elongation of the sheet vertically.

On still another road two types of stays are used on the radial stayed boilers, one stay being the rigid type and the other the eye-bolt, with jaw sling stay used only in the three rows next to the flue sheet. Both types are successful, but the common stay is favored. In this road, however, there are very few cases of top flue leakage, and the greatest flue-sheet trouble is caused by the sheet cracking below the lower flues, the cracks extending from the flue hole downward to the throat sheet braces. This is the leaky flue zone of these boilers.

Mr. Wilson.—Efforts are being made to overcome the cracking out of flue holes by lowering the flue holes. Many flue holes have to be renewed long before the flue sheets are worn out. It is either necessary to remove the flue sheet and have a new top made, or to send it out for patching. A great many railroads will plug a small crack. In some conditions that is good, and in others it is not good. It is a source of annoyance and trouble. Wherever we put plugs in the flue holes it is necessary to fit firebrick over them, so that the water will squirt against the firebrick and not over the fire. We are welding up these cracks by the acetylene process. We also are putting in a larger radius at the top than at the sides. At the sides ¾ inch and at the top 2 inches. I believe that one of the causes of the flue holes cracking is due to the shape of the fire-boxes. On account of its oval end it has a tendency to crowd up towards the middle. I do not think T bars or sling stays or braces are practical. I have found them as rigid as rigid stay-bolts.

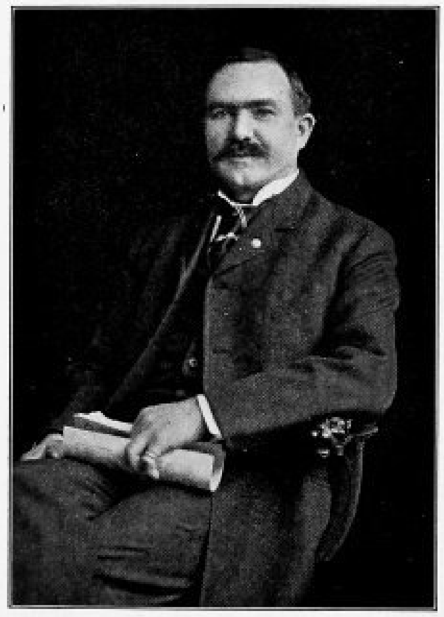
Mr. German.—The cause of most of the cracked flanges is overheating. No steel should be flanged at more than a cherry red. I believe in getting back to the ¾-inch radius. I do not think we will have as much trouble with cracked flanges.

Mr. Lowe.—Our company has built about ten or twelve modified Belpaire boilers, and this spring we have had to remove some side sheets out of those fire-boxes, and we did not observe any failure at the top flanges. I may also say that during four years that these engines have been in service we have had no difficulty with the outside sheets. In curing one disease we have prevented the other.

Mr. Bennett.—On the New York Central we tried the 2-inch radius at the top of the flange and also a 3-inch radius with no better results. The ¾-inch radius goes better with us and gives better results. On some roads the committee reports they have tried a 6-inch radius with no better results. It seems to me that a ¾-inch radius is better than a larger radius.

The President.—We have considerable experience with a crack on the roof sheet just back of the rivet holes on boilers whose corners are hips or angles, as you may call them. We find the crack running crosswise from 15 to 45 inches long. It is at the rear of the seam, at the inside calking edge of your dome course. You are familiar with the continuous throat sheet, which is a combination of the throat and the knuckle altogether. The crack presents itself just ahead or in the immediate radius of the flange. This crack is hidden, and is a dangerous proposition. The only thing we are to overcome in radially stayed boilers is the cracking of the top flange of the flue sheet horizontally and from the flues hole out. The latter is largely caused by the over-rolling of the flues, the horizontal crack being started by lack of provision for expansion of the fire-box upwards. In that particular we are using sling stays with oblong holes.

Mr. Bennett.—I do not agree with the president when he says that applying sling stays or flexible stays will overcome



FRANK GRAY, TREASURER.

the cracking. It doesn't make any difference how much play you allow in these sling stays, it won't take care of the stretching out of the flue sheet. The crown sheet goes around the flue sheet, and you cannot stretch that.

P. J. Conrath.—We had eighty Belpaire engines on the Missouri Pacific, and I was not able to keep the power in service. We had to lay up the engines to make repairs. I applied a patch, but after the engine had been in service twelve to fourteen months we found out that the reinforced patch had begun to crack. I applied gusset strips 5½ by 1½ thick. They were riveted on the sides, and as far as I know that was the proper remedy.

There is a great deal in the way flues are worked. Some boiler makers will start in and work from one side to the other. You will find your sheets bulging in or out from the center. As far as flexible stays are concerned they are a good thing.

Mr. Wilson.—I know a Belpaire boiler that has been in use fifteen years and which has never given any trouble of that kind. It bears out my idea that these boilers were built with these gusset braces, and were set and stayed properly in the beginning. With the Belpaire boiler you have no broken radial stays to remove, or the trouble with the radial stays leaking in the outside sheets. You do not have a number of broken stay-bolts. You have no irregular surface to support. I would recommend the Belpaire boiler.

Mr. German.—This subject of bracing the front part of the boiler was taken up last year, and I mentioned then ten boilers with two crown bars across the front, with common crown-bar bolts driven up and a radial bolt through the crown sheet through these bars with a nut on underneath. There were 1 1/16 or 1¼ holes in the bar. Those boilers ran for eight years before they gave us any trouble. The radius of the knuckle of the flange was only ¾ inch. The first bolt, measuring from the outside of the sheet, measured 3½ inches. On our big boilers to-day we can measure from the front of the flue sheet as high as 7½ inches. I believe there is too much flexibility. It wants something closer to resist the upward movement.

It was voted that the subject be continued, with at least one of the old committee, for another year.

Steel Versus Iron Tubes: What Advantages and What Success in Welding.

The committee which had this subject in hand during the past year investigated the subject very thoroughly and obtained a vast amount of data and opinions from many sources, but were unable to find that either material is favored to the exclusion of the other. The greatest number reported that as far as actual service is concerned steel tubes give just as good service as iron tubes, and vice versa. No difficulty is found in welding steel tubes, provided an oil furnace is used. With an open coke or coal fire some trouble is experienced, due to the impurities in the fuel.

ABSTRACT OF REPORT BY MR. MC KEOWN.

Mr. McKeown submitted a statement showing the number of steel tubes worked and the cost thereof as compared with iron tubes, which were applied to several engines for test. The engines were in service for varying lengths of time, and averaged from 30,000 to 50,000 miles. Roughly, 20 or 25 percent more iron flues were worked than steel flues, making the cost of the iron from 15 to 25 percent greater.

ABSTRACT OF REPORT BY B. F. SARVER.

Mr. Sarver cited the case of one engine that has 2¼-inch by 21-foot tubes, which, when first turned out of the shop, was equipped with iron tubes and safe-ends, making a flue mileage of 47,230 miles. These flues were then removed and the same flues safe-ended with steel. After these flues had been applied the engine made a flue mileage of 68,361 miles, thus making a gain of 21,131 miles in favor of steel safe-ends. He has experienced no trouble with leakage with the steel safe-ends. He also reported tests made on twenty-eight freight locomotives which were equipped with steel tubes. The flue mileage of these engines averaged 75,000. The previous flue mileage in that particular location, equipped with iron flues, would not average over 50,000 miles per engine. This would make a gain of 25,000 miles in favor of steel. No trouble was experienced in welding steel ends to iron flues, and there was also less leakage with the steel.

Mr. Green.—We use iron flues and steel safe-ends mostly.

Mr. Bennett.—That is our practice on the New York Central, and we get good results.

M. O'Connor.—These engines I have made note of were applied with steel tubes throughout and no safe-ends set. They were all steel. We have first engine 202, Class A, carrying 289 tubes, equipped with steel and iron tubes, half and half, applied May, 1908. Tubes removed from this boiler Jan. 20, 1910. Total mileage made with these tubes without any renewals between May, 1908, and January, 1910, 103,663 miles. Condition of tubes after rattled and inspected: fourteen steel tubes badly pitted and scrapped; forty-nine iron tubes badly pitted and scrapped. All other tubes, both iron and steel, were repieced with safe ends and put back in same engine. Several of the tubes, iron and steel, replaced were slightly scarred, but not sufficient to scrap them. While engine was in service (passenger service) during her full mileage, flues, both iron and steel, gave us but very little trouble.

Engine 1,209. Steel and iron tubes applied to this engine April, 1908; removed December, 1909; approximate mileage 60,000. Condition of tubes after being removed: twenty-six steel slightly pitted; twenty iron slightly pitted; neither steel nor iron tubes in condition to be scrapped, and all were repaired with safe-ends and put back in engine, and in same location as removed. Condition of tube beads in fire-box end: steel, good; iron, soft and spongy.

Engine 1,193. Steel and iron tubes applied to this engine May, 1908, removed July, 1909. Condition of tubes when removed: twenty steel tubes pitted and scrapped; six iron tubes slightly pitted but not scrapped; all iron tubes repieced and replaced in boiler; all steel, except twenty, scrapped; replaced in boiler. Service: Iron tubes leaked quite frequently; steel tubes leaked occasionally; efficiency of beads in favor of steel.

Engine 1,189. Steel and iron tubes applied May, 1908, and removed October, 1909; 242 tubes. Condition of iron and steel tubes when removed from boiler: sixty-seven steel tubes in perfect condition; forty-six slightly pitted but not scrapped; eight badly pitted and scrapped; 121 iron tubes in perfect condition. All tubes except eight were repieced and replaced back in same boiler, same location.

Another engine, 1,234, which was later in a wreck. Steel and iron tubes applied to this engine May, 1908; forty-nine tubes removed from engine; twenty-four steel and twenty-five iron, October, 1909. Condition of tubes when romoved: fourteen steel tubes slightly pitted; ten steel tubes good condition; twenty-five iron tubes in good condition. All were repieced and replaced in the boiler. Engine is still in service, giving good satisfaction, with no tubes removed outside of the forty-nine as above mentioned.

The condition of water acts materially on the service we are getting. I also made a careful inspection of the fire-box flue beads in each one of these boilers. We find that we have had more trouble with leaks with the iron flue than we do with the steel. As to general use the steel has held up as well as the iron.

A. N. Lucas.—We are using mostly iron tubes, due to the fact that the steel tubes have been recently put on the market, and we are getting fairly good results with both steel and iron. We have a number of engines running with steel safe-ends which give us good results. On our own district we have 117 engines running with flues twenty-five months and over. Some of them ten years and over.

Mr. Linderman.—The New York Central are using charcoal-iron tubes, and welding on steel safe-ends. We are not experiencing any trouble with the welding whatever. We are getting very good results.

Mr. Stewart.—Recently we are using a charcoal safe-end on steel butts. We have no trouble in welding, and handle about 4,000 a month.

It was announced that the Talmage Manufacturing Company had offered to print and distribute to the members of the association the books of rules and formulas ordered published by the association as a compliment from the company.

It was voted to accept this generous offer with thanks.

FRIDAY MORNING SESSION.

Flexible Stay-Bolts Compared With Rigid Bolts—Best Method of Applying and Testing Same.

The chairman of this committee was unable to present anything new on this subject, since no information was received from other members of the committee, and there were no new developments along this line during the past year in the shops where he is employed. A thorough inspection was made, however, of one of our H-13 class engines, to which a full installation of flexible stay-bolts was applied three and a half years ago. Ten or twelve bolts in different parts of the fire-box were removed to discover whether there were any fractures or broken bolts. No defect of any kind was found in the bolts which were removed, and, although the writer personally inspected and sounded each bolt in the boiler, he could not discover one that was broken. He also applied straight edges along the sheet at different parts to see if there were any contortions or bulges which would denote a broken bolt. The fire-box, however, proved to be in normal condition, and this installation seems to prove the value of flexible stay-bolts and the high efficiency of the method in which they were applied.

B. F. Sarver.—The road I am connected with has applied 15 installations of flexible staybolts. These bolts have been examined from time to time. And we have never found any broken or defective bolts in any way. I personally think the flexible staybolt is doing as much good in preserving our fireboxes as anything we could possibly use.

The President (addressing Mr. Smythe).—At the American Locomotive Works you have removed a firebox that had flexible bolts?

J. H. Smythe.—We removed two boxes for the Chicago & Alton and I failed to discover one that had the least bit of a fracture. Two or three years ago one of our friends got up and said they found two. But to my mind there is nothing better for a boiler than flexible staybolts. If I was going to design a boiler I would have a total installation of flexible staybolts. I would have all the sides, and about three or four rows of sling-stays. I think that would eliminate your trouble with the top of the flue sheet cracking.

It is our standard practice to apply flexible staybolts in all high-pressure engines. We put 450 to 500 of these bolts in. We have removed some of the fireboxes and found some of these bolts, when we have been taking the box out, with the heads broken off. Some have been fractured. The location of these bolts have been in the outer row. We found about eight bolts on the outside row with the heads off, and eight or nine with the heads half broken. I believe these bolts are beneficial to the side sheets. We have no trouble with our side sheets.

We want to find a better method of testing these bolts. We have tried water pressure and steam pressure and air pressure. After these tests have been made we strip the jacket and the bolts we found broken we take out. We find better results with water pressure of 100 to 125 pounds. That is the way we are trying to locate the broken bolts.

Mr. McKeown.—We have been applying flexible staybolts to our throat sheets for the last five years, and I have yet to find the first broken flexible bolt. I think the bolt is all right

J. H. Smythe.—There are two things that could be the cause of broken staybolts; first, poor material; second, someone might put a greater strain on those bolts, and that might cause breakage. It has been suggested that we ease up those bolts. To my mind I think it is going to prove all right. If we put a greater strain on one bolt than another, you have got more presure on that bolt; and we cannot condemn the method because a few of them break.

It was voted that the report of the committee be accepted, and that the flexible bolt be recommended as the best known remedy for relieving the expansion and contraction of the boiler, and that the committee be discharged.

Best Method of Applying Flues, Best Method for Caring for Same while Engine is on the Road and at Terminals and Best Tools for Same.

The best method of applying flues is to have the flues fit perfectly tight in the copper. The copper should be tightened in the sheet with a sectional expander not rolled. Then tighten the flues with a roller expander and roll the lower edges tight enough to hold the flues while belling out. Then prosser them with a prossering tool 1-16 inch wider than the thickness of the sheet. After they are prossered bead them with a standard beading tool.

The best method for caring for flues while on the road is, in our opinion, to have the flues cleaned of all cinders and soot, to keep the temperature of steam as regular as possible, and to keep a clean fire. On the New York Central lines, particularly on the Lake Shore, we use arch tubes and a brick arch. This arch is a great protection for the flues, and the way the arch is applied right close to the flue sheet excludes the cold air from striking the flues. We have very little trouble with leaking flues, but as a precautionary measure at every washout, which occurs every seven days, we blow out the flues and clean off the top of the brick of all cinders and accumulation, if any. Also as a precautionary measure we give our flues a monthly prossering, whether they leak or not.

The best tools, in our opinion, are the prosser expander, and a standard beading tool to conform and take in 3-16 inch stock for the fire-box end. John German, Chairman.

C. L. Wilson.—On the Rock Island railroad we properly prepare the hole; and if the flue sheet has any superfluous metal on it we work it off. We cut it off with a milling tool. It does not make much to trim off. The flue holes are reamed out and the coppers are properly fitted and rolled. The flue is entered and pounded up. The flue is then beaded down two-thirds of the way, and the flue is prossered and calked. When the old sheet comes in it is wavey more or less. By rolling the flue and beading it down, we get the bead on the angle with the sheet. When you prosser the flue out, it works better. In beading the flue you disturb the flue in the sheet. You come along and take them all out by prossering the flue. Then when you calk your flues you are not going to disturb your flue in the hole.

We prosser by a long stroke hammer. We do not advocate the calking of flues with water or steam in the boiler. Under ordinary practice the flues are expanded, and we do not calk them. But when the engine comes in for washing we calk the flues.

A. N. Lucas.—We turn our flues over by hand; we bell them out and hit them with the flat of the hammer. We do all of our expanding with a 3½-pound maul, with a 20-inch handle.

J. W. Kelly.—We are about to adopt a time limit to leave flues in the boilers. We think three years a sufficient time for a flue to stay in a boiler.

W. H. Laughridge.—The Hocking Valley has adopted a rule to remove the flues after an engine had made so many miles, regardless of the condition of the flues. The time set was taken from the average miles run on the different divisions. We have found it to be a very good practice. Speaking of the setting of flues it seems to me that belling flues over with the hammer and unnecessary rolling is injurious to the flues.We drive them in, and the man uses a hammer to lip the flues so that they won't back out. After he gets the flues seated his expander rotates around until the flues are solid. We beat them down solid. We give them a very light rolling afterwards. I do not approve of working a flue any more than is absolutely necessary.

C. W. Lewis.—We do not use the hammer at all on flues. We never allow a man to put a hammer on flues. When we get the flues all in we begin to set them. We do not affect the end of the flues at all. Then we prosser them all over. Then we bead them. The less work you can do the better it is. I believe that boiler makers have to meet the conditions where their engines are in service. We have to differ some from the standards under certain conditions.

P. J. Conrath.—We had about 21 Pacific Type engines with 21-ft. flues and they were a continuous annoyance with the tubes leaking. And we found that by welding a 2-in. piece for nine inches at the back end, giving us that much more bridge and bigger water space, we got considerably better results from those engines. Another reason was that some of the engines having the dome right over the back flue-sheet raised the water and pulled the water away from the flue sheet; and you will find the flues loose. We renewed the back flue sheet. In addition to the better circulation of water we managed to keep the flues cleaner.

John German.—I wish to corroberate Mr. Conrath's statements in regard to the reducing of 2¼-inch tubes to two inches when applying a new flue sheet. I tried that on the Lake Shore six years ago. We reduced the flues by swedging them back four inches. We put in a two-inch hole instead of a 2¼. On the Lake Erie & Western we had trouble with flues on account of bad water. Every new flue sheet that we put in I had the holes drilled to 1⅞ inch. Our mileage on that road with the two-inch holes was about 10,000 to a set of flues. After we reduced them we increased the mileage from 35,000 to 40,000 miles. The New York Central lines adopted that as a standard, and are getting good results from the same.

It was voted that the subject be continued another year.

Federal Inspection of Locomotive Boilers.

Senate Bill 6702, relating to Federal Inspection of Locomotive Boilers was read by Mr. Laughridge.

The President.—The more I hear of this bill the more vague it appears to me. In the first place the cost to the United States government will certainly be enormous. That is somewhat immaterial to us, but what is the expense going to be to the railroad companies whom we so loyally try to serve? Three hundred inspectors are required. You know as well as I that they would not begin to accomplish the purpose they set out for. Bear in mind that this so-called local inspector is invested with the power, backed by the Government of the United States, to act then and there in your presence. He can claim any locomotive as he deems fit for supervision or inspection.

Some of the best railroad men in the United States oppose this bill. We did succeed in referring back two of these bills to be modified. As this bill stands, it is so vague that I, personally, could not and would not recommend it to our United States Government to be enacted as a law.

C. L. Hempel.—The railways of to-day are doing more to maintain a better supervision of boiler inspection than possibly could be maintained by a State or Federal supervision. The provisions are made for certain times of boiler inspection in the bill which has been read. But are these sufficient? It is necessary to make inspection according to the localities. And it is impossible to make a bill to meet every condition upon the various railways of this country. I do not propose to let a bill of that kind destroy my supervision of boiler inspection on the road with which I am connected. I have a better system than that bill could possibly give us. For example, it may be necessary, in my judgment, that a boiler should be inspected each trip and if I thought it would be necessary I would issue those instructions. And every time the engine makes a trip the boilers are inspected; every 30 days there is an external inspection; and every time the engine is shopped an internal inspection is made.

If this system proposed by this bill is made a law who would permit the railroads from being imposed upon by the bill? By a bill of this kind, backed up by whom? You all know whom. Presented to Congressman Burkett by Mr. Jeffrey. What is he working for? It is a political graft. If we are going to put our supervision of boilers in politics it is time for us to get out of business and give it to them.

We do not want a boiler on any railroad that is liable to put one dollar in the general claim agent's hands. These troubles cause claims and it is up to us to maintain this inspection without being forced by the Federal or State supervision.

The President.—Government statistics show that during six years' service of 60,000 engines there were 1.3 percent of the boiler explosions in the United States due to defects in the locomotive boilers as against 98.7 percent of boiler explosions due to other causes.

George L. Fowler.—In talking about the subject of State boiler inspection, there is really nothing to be said. I think Mr. Crawford, who appeared before the committee, echoes the sentiment when he said that his road would not object to boiler inspection. They have supervising boiler inspection in New York and Pennsylvania, in which they have taken the recommendations of the railroad company and incorporated them into a law. No one can object to that. But that doesn't interfere and try to come in and tell you what you shall do. They accept the inspection of the railroad company.

This bill proposes to put inspectors broadcast through the country to inspect boilers once in three months. Railroads do better than that from three to 180 times so far as actual inspection is concerned. This inspection law would be a farce and an imposition. What do they do? The law is vague. You read the expressions. "The boiler should be well made." It does not mean anything whatever. And similar expressions. Here is a new inspector who comes before men who have been engaged for years in special work in building boilers. A man of five years' experience comes in and tells them what they are to do, and how they are to do it. Nobody but a politician would have drawn such a bill or backed it up. They use the word "sufficient." What does it mean? It does not mean anything. You know enough about boiler inspection to know that we want something definite instead of this vague language, and these vague things. A man comes in and makes a superficial inspection of a boiler. I say that boiler is all right and you send the boiler out. Nobody can tell by a superficial inspection whether it is safe or not. How can one man do what you have a dozen men to do every time a boiler comes into the shop? The whole thing hinges on the absurdity of the Government trying to do this thing.

If you can get a bill before Congress that will prevent a locomotive engineer from letting his water get low in a boiler, it would be a mighty good thing. A man may be a thoroughly competent man but here is a bill that provides if an engineer allows a crown sheet to come down, whether he is responsible or not, he is allowed to collect damages against the railroad for his own negligence.

With such a condition as that before you there is only one thing to do and that is to pass by a unanimous vote an utter condemnation of this bill, and send it back to Washington and let them know what you really think about it.

It was voted to appoint a committee to draw up resolutions condemning the bill.

Abstract of Report on Standardizing of Blue Prints.

The chairman of the committee, in the absence of reports from the other members of the committee, recommended that members of the association present this subject to their respective superintendents of motive power, emphasizing the convenience which would be derived from a system of standard blue prints, so that the opposition to the establishment of such a system on the part of locomotive boiler builders could be overcome. It was stated that such a system would be economical for the builder and much more so for the railroads, and a time-saver for both. The saving of time is of particular importance to the railroads, since when repairs are being made the engine is out of service, and to the cost of the work must be added the loss of the earning power of the engine. As a preliminary step the chairman outlined a few of his ideas, requesting criticism. His recommendations were as follows:

1. For an accurate skeleton box templet for laying off mud-rings.

2. That box or band templets be furnished for all flanged work.

3. That all fire-box plates be laid off accurately from templets, the rivet holes uniformly spaced and a center line maintained in each seam throughout.

4. That the door hole flange be accurately gaged and rivet holes uniformly spaced, maintaining center holes vertically and horizontally.

5. That all holes in the back head and throat sheet be laid off from templets.

6. That the outside side sheets and roof or wrapper sheet be laid off from templets and a center hole maintained top and bottom of the side sheet and fore and aft in the roof sheet. All holes to be punched or drilled before assembling.

7. Cylinder courses to be bisected into four equal parts and the rivet holes uniformly spaced, with a center hole maintained on the vertical and horizontal center of the boiler throughout.

8. That the dome collar be put up, the collar fitted in, leveled and marked off from the holes in the dome course.

9. That rivet holes in the smoke-box door ring and filler ring be laid off from band templets, with bolt holes in the door ring to be laid off from skeleton ring templets.

10. That all tees, angles, crowfeet, lugs, washout flanges, etc., be laid off from templets.

11. Rivet holes in front tube sheet flange to be laid off from band templets. Flue and brace holes to be laid off from templets.

G. W. Bennet.—I think the committee is trying to accomplish too much at one time. They should try to get the manufacturers to get out prints of a firebox and then take up other parts of the boiler. Every boiler maker knows what an advantage it is to have a blue print, knowing that that blue print is right. In other words they ought to have a blue print for a one-piece fire-box, another one for a flue sheet, another one for a back-head. If we could agree to that first it would be a great advantage. And then we could take up the other parts.

Mr. Kelly.—The small details should be checked up on blue prints. One locomotive works builds boilers with a ⅞ rivet, and another with a 15-16 rivet.

C. L. Hempel.—It seems to me that the matter lies wholly with the various railways. Each railway has a common standard. They are drifting that way to-day. I am thoroughly in favor of a standard of templets. It only remains for each railway company to be positive as to the number of holes they apply. I do not hink any layout could vary to such an extent that there would be any difference to speak of.

W. H. Laughridge.—I have said in my paper that it is up to the master boiler maker to go to his superintendent of motive power and get the backing of the railroad officials. Then you can force the locomotive people to give you developed blue prints of all the work. We contemplated getting some new power, and I suggested that we embody in our specifications that we have developed blue prints of all the sheets of the boilers. We embodied that in the specifications. The contracts were let, but they refused to furnish blue prints of the deleloped sheet, claiming it was too much work, etc. But if all the railroads would join in and say to the locomotive builders that we must have developed blue prints; it will be money for the builder and money for the railroad.

Mr. Kelly.—I think that if we could get the manufacturers to get down to a standard on throat sheets it would be a great benefit to all railroads.

It was voted to continue the subject.

Resolutions on the deaths of Thomas C. Best, E. B. Cavanaugh, Frederick G. Bloom and William Burns were read, and it was voted that the resolutions be published in the proceedings, and a copy of the resolutions be sent to the surviving members of the families of the deceased members.

Mr. Goodwin then read his resignation as chairman of the Executive Committee, but by a unanimous vote the association requested him to continue to hold the office until the expiration of his term.

FRIDAY MORNING SESSION.

Resolutions Adopted Regarding Federal Locomotive Boiler Inspection Bill.

Whereas, A bill known as No. S. 6,702 has been presented to the Congress of the United States for the avowed purpose of promoting the safety of employees and travelers upon railways by compelling all common carriers to equip their locomotives with safe and suitable boilers and appurtenances thereto; and

Whereas, The language employed in the said bill by which such safety is to be obtained is indefinite and uncertain and in no way conveys any engineering information whatever that can serve as a guide for boiler construction and maintenance; and

Whereas, The bill provides for a system of inspection that is impossible of execution with the force that will be available, thus rendering it absurd and useless; and

Whereas, There is no method suggested by which competent inspectors will be selected; and

Whereas, It provides that the government will undertake the inspection without assuming any responsibility for the same; and

Whereas, Such a system of inspection will tend to lessen the vigilance of employees without, at the same time, relieving them of responsibility; and

Whereas, The training of the men made eligible for inspectors is not sufficient to insure their competency; and

Whereas, Such a system of inspection will hamper commerce by delaying engines at terminals; and

Whereas, The expense involved will be very great without any compensating advantages therefor, and will, therefore, be a burden to maintain; therefore be it

Resolved, That we, the International Master Boiler Makers' Association, condemn the said bill, S. 6,702, as it is now drawn, as not only useless but detrimental to the best interests of the railways, their employees and the traveling public, and unanimously deprecate its passage and urge that it be reported unfavorably, and that it be further

Resolved, That copies of this resolution be sent to Congressmen and Senators in charge of the bill and members of the Inter-State Commerce Commission and the press.

Thirty-two new members were elected to the association, making a total of forty-two admitted during the year. Reports were read from the committees on resolutions and on subjects for the next meeting. It was voted that the retiring president act as a delegate to the convention of the American Boiler Manufacturers' Association. Omaha was selected as the 1911 convention city, and the following officers were elected for the ensuing year:

President, A. N. Lucas, Milwaukee, Wis.

First Vice-President, George W. Bennett, Albany, N. Y.

Second Vice-President, J. W. Kelly, Chicago, Ill.

Third Vice-President, T. W. Lowe, Winnipeg, Manitoba, Canada.

Fourth Vice-President, J. T. Johnston, Los Angeles, Cal.

Fifth Vice-President, F. A. Linderman, Albany, N. Y.

Secretary, Harry D. Vought, New York City.

Treasurer, Frank Gray, Bloomington, Ill.

Messrs. M. O'Connor, J. R. Cushing and C. J. Murray were elected to fill vacancies in the executive committee.

The following members and guests attended the convention:

W. J. Hurley, Road Foreman of Engines, New York Central, Buffalo, N. Y.; Geo. W. Doran, Assistant Supervisor of Boilers, Lake Shore & Michigan Railroad, Cleveland, Ohio; George Beland, Forman, Boiler Department, Erie; William F. Miller, Assistant Supervisor of Boilers, New York Central, Buffalo; F. G. Bird, General Foreman Boiler Maker, American Locomotive Co., Schenectady, N. Y.; Ethan I. Dodds, Assistant Superintendent, Erie, Meadville, Pa.; C. F. Young, Assistant Supervisor Boilers, Lake Shore & Michigan Southern, Elkhart, Ind.; Geo. F. Dunn, Supervisor of Boilers, Big Four, Indianapolis, Ind.; F. D. Timms, Foreman Boiler Maker, C. H. & D., Indianapolis, Ind.; D. S. Rice, Foreman Boiler Maker, P. R. R., Pittsburg, Pa.; F. A. Batchman, Foreman Boiler Maker, New York Central, Elkhart, Ind.; Chas. J. Klein, Boiler Inspector, New York Central, Albany, N. Y.; J. A. Dailey, Foreman Boiler Maker, Murray Iron Works, Burlington, La.; S. J. Wigmore, Foreman Boiler Maker, Norfolk & Western, Roanoke, Va.; James C. Clark, Master Boiler Maker, Philadelphia & Reading, Reading, Pa.; John B. Murray, Assistant Foreman Boiler Maker, Pennsylvania R. R., Trenton, N. J.; W. J. Graham, Supervisor Locomotive Machinery, Lake Shore, Cleveland, Ohio; John German, Supervisor of Boilers, Lake Shore, & Michigan Southern, Kankakee, Ill.; L. Borneman, Foreman Boiler Maker, C. St. Paul, M. & Omaha, St. Paul, Minn.; H. J. Wandberg, Foreman Boiler Maker, C. M. & St. Paul, Minneapolis, Minn.; W. E. Hawkes, Foreman Boiler Maker, Lake Shore, Astabula, Ohio; F. A. Griffen, General Foreman Boiler Maker, Southern Railway, Spencer, N. C.; C. R. Kurrasch, Foreman Boiler Maker, C. I. & S. R. R., Kankakee, Ill.; H. D. Vought, New York; C. N. Nau, Foreman Boiler Maker, C. I. & S., Hammond, Ind.; A. Hedberg, Foreman Boiler Maker, Ch. N. W., Winona, Minn.; J. B. Tate, Foreman Boiler Maker, P. R. R., Altoona, Pa.; J. R. Cushing, Foreman Boiler Maker, Big Four, Bellefontaine, Ohio; T. J. McKerihan, Foreman Boiler Maker, P. R. R., Altoona, Pa.; R. W. Clark, Foreman Boiler Maker, N. C. & St. L., Nashville, Tenn.; John B. Smith, Foreman Boiler Maker, Pittsburg & Lake Erie, McKees Rocks, Pa.; B. F. Sarver, Foreman Boiler Maker, P. R. R., Fort Wayne, Ind.; J. J. Casey, Foreman Boiler Maker, New York Central, New Durham, N. J.; John Troy, Foreman Boiler Maker, Pere Marquette, Saginaw, Mich.; J. C. Keefe, Foreman Boiler Maker, T. & O. C., Bucyrus, Ohio; H. W. Peterman, Foreman Boiler Maker, S. P. Co., Sparks, Nev.; P. F. Flavin, Standard Railway Equipment Co., St. Louis, John McKeown, Foreman Boiler Maker, Erie, Galion, Ohio; M. Wulfeck, Foreman Boiler Maker, C. & O., Covington, Ky.; W. Kells, Master Mechanic, Lehigh Valley, Buffalo, N. Y.; D. S. Rice, Foreman Boiler Maker, P. R. R., Pittsburg, Pa.; R. P. Crimmins, Foreman Boiler Maker, Big Four, Mattoon, Ill.; Albert H. Conley, Foreman Boiler Maker, P. R. R., Olean, N. Y.; J. J. Mansfield, Chief Boiler Inspector, Central Railroad of New Jersey, Jersey City, N. J.; N. Emch, Foreman Boiler Maker, Lake Shore, Toledo, Ohio; Chas Kraus, Foreman Boiler Maker, Big Four, Delaware, Ohio; T. W. Lowe, General Boiler Inspector, C. P. R. R., Winnipeg, Canada; E. W. Rogers, Foreman Boiler Maker, American Locomotive Co., Paterson, N. J.; B. Wulle, Foreman Boiler Maker, Big Four, Indianapolis, Ind.; J. T. Johnston, General Boiler Inspector, A. T. & S. F. Coast Line, Los Angeles, Cal.; F. L. Lothrop, Foreman Boiler Maker, Erie, Susquehanna, Pa.; Charles Lothrop, Susquehanna, Pa.; Wm. Lindner, Foreman Boiler Maker, Central of Georgia, Savannah, Ga.; J. H. Smythe, Bellevue, Pa.; E. C. Cook, *Railway Journal*, Chicago, Ill.; C. F. Petzinger, Foreman Boiler Maker, Central of Georgia, Macon, Ga.; Alfred Cooper, General Foreman Boiler Maker, St. J. & G. I. Railway, St. Joseph, Mo.; C. Ryan, Foreman Boiler Maker, Union Pacific, Omaha, Neb.; J. B. Tynan, Foreman Boiler Maker, Wheeling & Lake Erie, Norwalk, Ohio; Andrew S. Green, General Foreman Boiler Maker, Big Four, Indianauolis, Ind.; C. Baumann, Foreman Boiler Maker, N. Y.; N. H. & H., New Haven, Conn.; John McNamara, Foreman Boiler Maker, L. E. & W., Lima, Ohio; H. E. Morrow, General Foreman Boiler Maker, I. & G. N. Palestine, Texas; J. E. Hennessey, Foreman Boiler Maker, New York Central, Syracuse, N.Y.; A. S. Bartle, Foreman Boiler Maker, New York Central, E. Syracuse, N. Y.; C. W. Musser, Foreman Boiler Maker, Cumberland Valley, Chambersburg, Pa.; E. R. Kyler, Superintendent Boiler Department, Waterous Engine Works, Brantford, Canada; James Bruce, Foreman Boiler Maker, Frisco Line, Kansas City, Kan.; W. A. Bruce, Kansas City, Kan.; C. J. Raynolds, Foreman Boiler Maker, B. & O., Pittsburg, Pa.; J. A. Powell, Foreman Boiler Maker, Central of Georgia, Columbus, Ga.; E. W. Young, Boiler Inspector, C. M. & St. Paul, Dubuque, Iowa; Lee M. Stewart, Master Boiler Maker, Atlantic Coast Line, Waycross, Ga.; M. O'Connor, Foreman Boiler Maker, Chicago Northwestern, Missouri Valley, Iowa; W. E. Clark, Foreman Boiler Maker, Hendrick Manufacturing Co., Carbondale, Pa.; A. E. Brown, General Foreman Boiler Maker, L. & N., South Louisville, Ky.; J. J. Orr, Foreman Boiler Maker, Lackawanna, Scranton, Pa.; J. J. Madden, Foreman Boiler Maker, Rock Island, Fairburg, Neb.; J. F. Beck, Foreman Boiler Maker, G. R. & I., Grand Rapids, Mich.; F. A. Linderman, Supervisor of Boilers, New York Central, Albany, N. Y.; W. H. Laughridge, General Foreman Boiler Maker, Hocking Valley, Columbus, Ohio; C. L. Hempel, General Boiler Inspector, Union Pacific, Omaha, Neb.; J. E. Cooke, Master Boiler Maker, Bessemer & Lake Erie, Greenville, Pa.; A. N. Lucas, General Foreman Boiler Maker, C. M. & St. Paul, Milwaukee, Wis.; A. C. Dittrich, Foreman Boiler Maker, M. St. Paul & Sault Ste. Marie, Minneapolis, Minn.; B. F. Throckmorton, Foreman Boiler Maker, Waterous Engine Works Co., Brantford, Canada; J. W. Kelly, General Foreman Boiler Maker, Chicago & Northwestern, Oak Park, Ill.; R. N. Williams, Foreman Boiler Maker, A. C. Lines, Rocky Mount, N. C.; Clarence Reynolds, Layer Out, L. & N. R. R., Louisville, Ky.; Hubert M. Bruder, Gang Foreman, L. & N. R. R., New Albany, Ind.; H. J. Dickman, Foreman Boiler Maker, A. C. Iine, Florence, S. C.; R. E. Weiss, Foreman Boiler Maker, Ala., Great Southern, Birmingham, Ala.; G. W. Bennett, General Foreman Boiler Maker, New York Central Albany, N. Y.; W. McKeown, Foreman Boiler Maker, Lehigh Valley, Buffalo, N. Y.; J. T. Bond, General Boiler Inspector, N. Y. N. H. & H. New Haven, Conn.; J. T. Goodwin, Tube Expert, National Tube Co., Pittsburg, Pa.; Thos. R. Oliver, Foreman Boiler Maker, Detroit & Mackinaw Railway, East Tawas, Mich.; O. E. Water, Foreman, American Locomotive Co., Dunkirk, N. Y.; Lewis S. Johnson, Foreman Boiler Maker, Colorado & Southern, Denver, Colo.; M. F. Vizard, Foreman Boiler Maker, Pere Marquette,, Ionia, Mich.; James Crombie, Foreman Boiler Maker, Sawyer-Massey Co., Hamilton, Ontario, Canada; D. W. Bauer, Foreman Boiler Maker, Toledo Terminal, Toledo, Ohio; Geo. M. Rearick, General Boiler Inspector, Buffalo & Susquehanna, Galeton, Pa.; Robert U. Wolfe, Chief Inspector of Boilers, City of Omaha, Omaha, Neb.; P. S. Hursh, Blaw Collapsible Steel Centering Co., Reynoldsville, Pa.; George G. Fisher, Foreman Boiler Maker, C. & W. I. & Baltimore Ry. of Chicago, Chicago, Ill.; T. G. Smallwood, Chicago Pneumatic Tool Co., Birmingham, Ala.; J. C. Campbell, Chicago, Pneumatic Tool Co., Chicago, Ill.; Col. E. D. Meier, Heine Safety Boiler Co., New York; Geo. N. Riley, National Tube Co., Pittsburg, Pa.; Joe McAllister, Foreman Boiler Maker, D. L. & W., Buffalo, N. Y.; Warren Plowman, Foreman Boiler Maker, Big Four, Urbana, Ill.; M. J. Scullin, Assistant Foreman Boiler Maker, Lake Shore, Cleveland, Ohio; George Wagstaff, American Arch Company, New York; M. M. McAllister, Foreman Boiler Maker, Lake Shore, Cleveland, Ohio; F. E. Berrey, Foreman Boiler Maker, Erie, Cleveland, Ohio; G. L. Fowler, Consulting Engineer, New York; P. J. Conrath, National Tube Co., Chicago, Ill.; Hugh Smith, Foreman Boiler Maker, Erie, Jersey City, N. J.; G. S. Hewitt, Foreman Boiler Maker, N. & W., Portsmouth, Ohio; W. F. Fantom, Foreman Boiler Maker, C. & W. I., Chicago, Ill.; Thos. Lewis, General Foreman Boiler Maker, L. V., Sayre, Pa.; C. E. Lester, Superintendent, Davis-Bournonville Co., Jersey City, N. J.; W. H. Damon, Foreman Boiler Maker, Long Island R. R., Richmond Hill, Long Island; F. A. Mayer, General Master Boiler Maker, Southern Railway, Washington, D. C.; Jos. Sullivan, Foreman Boiler Maker, New York Central, Buffalo, N. Y.; F. M. Smith, Foreman Boiler Maker, Southern Railway, Princeton, Ind.; W. H. Hopp, Foreman Boiler Maker, C. M. & St. Paul, Dubuque, Iowa.; D. G. Foley, General Foreman Boiler Maker, D. & H. Co., Green Island, N. Y.; A. Sharpe, Foreman Boiler Maker, American-Bell Engine & Thresher Co., Ltd., Toronto, Ontario, Canada; T. L. Mallan, Foreman, P. R. R. N. Y.; W. Olsen, Boiler Inspector, New York Central, New York; G. P. Robinson, Inspector, New York Public Service Commission, Albany, N. Y.; T. E. McCune, Foreman Boiler Maker, Chicago, Rock Island & Pacific, Chickasha, Okla.; A. Feisner, Foreman Boiler Maker, I. C. R. R., Waterloo, La.; George Mack, Mechanical Engineer, New York Public Service Commission, Albany, N. Y.; Cornelius Bader, Foreman Boiler Maker, M. C. R. R. Detroit, Mich.

The following ladies were present: Mrs. George Beland, Hornell, N. Y.; Mrs. D. S. Rice, Pittsburg, Pa.; Mrs. J. A. Dailey and Miss P. A. Dailey, Burlington, La.; Mrs. J. B. Murray Trenton, N. J.; Miss B. Graham, Kankakee, Ill.; Mrs. F. A. Griffen, Spencer, N. C.; Mrs. C. R. Kurrasch, Kankakee, Ill.; Mrs. H. D. Vought, New York City; Mrs. C. N. Nau, Miss K. Nau, Miss Alice Murninghan, Hammond, Ind.; Mrs. J. B. Tate, Altoona, Pa.; Mrs. T. J. McKerihan, Altoona, Pa.; Mrs. B. F. Sarver, Fort Wayne, Ind.; Mrs. J. J. Casey and Miss L. Casey, New Durham, N. J.; Mrs John Troy, Saginaw, Mich.; Mrs. John McKeown, Galion, Ohio; Mrs. M. Wulfeck, Covington, Ky.; Mrs. D. S. Rice, Pittsburg, Pa.; Mrs. Albert H. Conley, Olean, N. Y.; Mrs. T. W. Lowe, Winnipeg, Canada; Mrs. B. Wulle, Indianapolis, Ind.; Mrs. J. T. Johnston, Los Angeles, Cal.; Mrs. F. L. Lothrop, Susquehanna, Pa.; Mrs. J. H. Smythe, Bellevue, Pa.; Mrs. C. F. Petzinger, Macon, Ga.; Mrs. Alfred Cooper, St. Joseph, Mo.; Mrs. J B. Tynan, Norwalk, Ohio; Miss G. Green, Indianapolis, Ind.; Mrs. C. Baumann, New Haven, Conn.; Mrs. James Bruce, Kansas City, Kan.; Mrs. E. W. Young, Dubuque, Iowa; Mrs. Lee M. Stewart and Miss L. Stewart, Waycross, Ga.; Mrs. M. O'Connor, Missouri Valley, Iowa; Miss I. M. Brown, S. Louisville, Ky.; Mrs. J. J. Madden, Fairburg, Neb.; Mrs. W. H. Laughridge, Columbus, Ohio; Mrs. C. L. Hempel and the Misses H. and G. Hempel, Omaha, Neb.; Mrs. J. E. Cooke and Miss M. I. Cooke, Greenville, Pa.; Mrs. G. W. Bennett, Albany, N. Y.; Mrs. W. McKeown and Miss H. McKeown, Buffalo, N. Y.; Mrs. J. T. Goodwin, Pittsburg, Pa.; Mrs. Thos. R. Oliver, East Tawas, Mich.; Mrs. James Crombie, Hamilton, Ont.; Canada.; Mrs. George M. Rearick, Galeton, Pa.; Mrs. Robert U. Wolfe, Omaha, Neb.; Mrs. P. S. Hursh, Reynoldsville, Pa.; Mrs. Charles Palmer and Miss Lois Palmer; Mrs. George N. Riley, Pittsburg, Pa.; and the Misses Hammond and Murphy, Buffalo, N. Y., Mrs. Joe McAllister, Buffalo, N. Y., Mrs. Warren Plowman, Urbana, Ill.; Mrs. F. E. Berrey and Miss E. Berrey, Cleveland, O.; Mrs. P. J. Conrath, and Miss Hunt, Chicago, Ill.; Mrs. W. F. Fantom, Chicago, Ill.; Miss E. Mayer, Washington, D. C.; Mrs. Joseph Sullivan, and the Misses D. and A. Sullivan, Buffalo, N. Y.; Mrs. F. M. Smith, Princeton, Ind.; Mrs. Cornelius Bader, Detroit, Mich.

Mrs. H. F. Gilg, Miss Anna Gilg, Miss Martha Gilg, Pittsburg, Pa. Mrs. H. C. Hunter, Parkesburg, Pa. Mrs. J. T. Goodwin, Pittsburg, Pa. Mrs. J. J. Keefe, Chicago, Ill. Mrs. Geo. J. Thust, Moberly, Mo. Mrs. C. E. Walker, Chicago, Ill. T. F. Degarmo, S. Bethlehem, Pa.

Boiler Makers' Supply Men's Association.

Although the convention was held this year at a place where the natural advantages offered many opportunities for individual entertainment, yet the Supply Men's Association provided a most enjoyable programme of entertainment for the entire convention, which filled in practically all the time when the Association was not holding its regular meetings.

On Tuesday evening there was a reception and dance in the ball room of the hotel. Wednesday afternoon the ladies were conducted on a trip through the home of the Shredded Wheat Biscuit. At 6:45 P. M. the members and guests of the convention assembled promptly and boarded special cars for Buffalo, where the evening was spent at Shea's "Star" Theater. On Thursday morning, the entire convention was taken by trolley over the Great Gorge Route, stopping at Queenston Heights to visit the park and Brock's monument. In the afternoon a euchre was held for the ladies in the hotel parlors, while the annual banquet was held in the evening. Friday morning the ladies were given a carriage ride, visiting all points of interest on the American side of the Falls. Music for dancing was provided for those who remained at the hotel Friday evening.

At the annual meeting of the Boiler Makers' Supply Men's Association the report of the Secretary-Treasurer showed the affairs of the Association to be in satisfactory condition. It was voted that in future the names of contributors to the Entertainment Fund should be omitted from the programme of entertainment. The following officers were elected for the ensuing year:

President, S. F. Sullivan, Ewald Iron Company, St. Louis, Mo.

Vice-President, W. H. S. Bateman, Champion Rivet Company, Philadelphia, Pa.

Secretary-Treasurer, George Slate, The Boiler Maker, New York City.

The following members of the Supply Men's Association attended the convention:

W. H. S. Bateman, Philadelphia, representing the Champion Rivet Co., the Parkesburg Iron Co., and the Chicago Pneumatic Tool Co. Carter Blatchford, Chicago, Spencer-Otis Co., representing the Tyler Tube & Pipe Co. H. H. Linton, New York, Fuller Bros. & Co., representing S. Severance Mfg. Co. J. G. Talmage, Cleveland, E. H. Janes, J. F. Walker, Talmage Mfg. Co. F. W. Severance Pittsburg, Samuel Severance, Pittsburg, John J. Wirth, Birmingham, Ala., S. Severance Mfg. Co. Henry F. Gilg, Pittsburg, J. A. Shay, Connellsville, Pa. Sligo Iron & Steel Co. Fred Gardner, Jos. T. Ryerson & Son, Chicago. O. H. Ferguson, New York, Richard R. Harris, New York, Pittsburg Steel Products Co. L. P. Mercer, Chicago, George Thomas 3rd, Parkesburg, H. A. Beale, Jr., Charles L. Humpton, H. C. Hunter, Parkesburg, J. A. Kinkead, New York, W. H. Colman, Parkesburg, Parkesburg Iron Co. Geo. E. Levey, Otis Steel Co., Cleveland. G. N. Riley, J. T. Goodwin, Pittsburg,

S. R. Phillips, Chicago, F. N. Speller, Pittsburg, Pa., National Tube Co. J. J. Keefe, Independent Pneumatic Tool Co., Chicago. Charles Dougherty, New York, William H. Armstrong, New York, Ingedsoll-Rand Co. P. S. Rhodes, Homestead Valve Mfg. Co., Homestead, Pa. G. E. Howard, Weehawken, N. J., J. R. Flannery, Pittsburg, B. E. D. Stafford, Pittsburg, Thomas R. Davis, Pittsburg, W. M. Wilson, Chicago, Flannery Bolt Co. J. W. Faessler, Moberly, Mo., George J. Thust, Moberly, Mo., C. F. Palmer, St. Louis, Mo., J. Faesler Mfg. Co., S. F. Sullivan, St. Louis, Mo., Ewald Iron Co., C. A. Carscadin, Chicago, T. B. Kirby, Chicago, H. S. White, Detroit, Detroit Seamless Tubes Co. C. E. Lester, Jersey City, John Grosart, Jersey City, William Joyce, New York, Davis-Bournonville Co. C. C. Swift, Cleveland, Punch & Shear Works, Cleveland. R. J. Venning, Cleveland Steel Tool Co., Cleveland. J. W. McCabe, New York, T. G. Smallwood, Birmingham, Ala., R. Watson, Buffalo, Charles E. Walker, Chicago, Thomas Aldcorn, New York, J. C. Campbell, Chicago, Chicago Pneumatic Tool Co. H. S. Covey, Cleveland, J. T. Graves, Cleveland, Cleveland Pneumatic Tool Co. Christopher Murphy, Christopher Murphy & Co., Chicago., W. L. Kerlin, Carpenter & Kerlin, New York. A. T. Collins, Crucible Steel Co., Buffalo. Charles Kennedy, Brown & Co., Chicago, H. H. Brown, G. R. Slate, THE BOILER MAKER, New York. W. C. Cutler, S. Bethlehem, T. F. DeGarmo, Chicago, Bethlehem Steel Co. C. B. Moore, New York, George Wagstaff, New York, J. L. Nicholson, New York, American Arch Co. Thomas Draper, Draper Mfg. Co., Port Huron, Mich. D. J. Champion, Champion Rivet Co., Cleveland. Geo. A. Gallinger, Independent Pneumatic Tool Co., Pittsburg, J. A. Warfel, Pittsburg, E. E. Radcliffe, Buffalo, Geo. M. Bailey, Chicago, Linde Air Products Co. F. H. Snell, Buffalo, W. H. Wood Loco. Fire Box & Tube Plate Co.

EXHIBITS AT THE CONVENTION.

Several members of the Supply Men's Association had interesting exhibits at the Convention, among which were the following:

Flannery Bolt Company: This well-known concern had a complete exhibit of Tate flexible staybolts, including their newly designed crown bolts. Some of the attachments were shown in section, so that a splendid idea could be obtained of both the construction and installation. There was also a full exhibit of the tools used in the application of Tate bolts. Numerous photographs showing complete and partial installations were also exhibited.

Parkesburg Iron Company: A good many boiler makers have had no opportunity to see the process of manufacture of charcoal iron boiler tubes. The exhibit of the Parkesburg Iron Company, which included a large transparency, containing thirty-six excellent views of the different operations involved in the making of lap welded charcoal iron tubes therefore proved of exceptional interest. The views were arranged in the order in which the work is performed from the first process to the finished tube, showing the frequent tests to which the tubes are subjected in the process of manufacture. The company also had some interesting samples of boiler tubes, showing the manner in which the iron withstands bending and upsetting tests, etc. Souvenirs were distributed in the form of loose-leaf note books.

William H. Wood Loco. Firebox & Tube Plate Company: Blue prints of the corrugated firebox and tube sheets manufactured by this company have been exhibited at previous conventions, but at the present convention an entire section of a firebox and sections of front and back tube plates were exhibited. Souvenirs were distributed in shape of watch fobs bearing an impression of the corrugated firebox.

Chicago Pneumatic Tool Company: A varied assortment of the pneumatic riveting, chipping, calking hammers and air motors and drills, manufactured by this company, were on exhibition. Of particular interest were their improved ball bearing drills, compound drills for setting flexible staybolts, and reaming and their size E. R. drills for heavy tapping, drilling and reaming. Their souvenirs consisted of pencils.

Pittsburg Steel Products Company: This company exhibited an interesting collection of photographs of their plant, showing the different operations carried out in the manufacture of their tubes. A large collection of tubes was also exhibited, showing the effect of beading, flattening, belling out, twisting, etc.

Ingersoll-Rand Company: This company had a valuable exhibit of their Crown rotary drills, Imperial pneumatic hammers and Imperial air hoists. Two of the hammers were shown in section, giving an excellent opportunity to study the construction and operation of the tools.

Cleveland Punch & Shear Works Company: One of the most unique exhibits at the convention was the small model of the Cleveland Punch & Shear Works Company's standard punch. This punch was attached to an electric motor and, therefore, the machine could be seen in operation. The model was complete in every detail and served to call attention to the solid frame type of construction adopted by this company. A large number of photographs and blue prints of the various machine tools manufactured by this company were also on exhibtion, as well as the tool sheet showing the standard sizes and shapes of punches and dies manufactured by this company.

S. Severance Manufacturing Company: A number of samples of the steel boiler rivets which had been subjected to various exacting tests were exhibited by the S. Severance Manufacturing Company, affording a good idea of the quality of material used in modern boiler rivets.

Davis-Bournonville Company: Oxy-acetylene welding has commanded considerable attention in the boiler making field recently, and the members and guests of the Association were enabled to see actual demonstrations of this process at the hotel as carried out by the Davis-Bournonville Company. One of the Davis-Bournonville 50-pound acetylene generators was on exhibition, although not in operation. The representatives of the company, however, had tanks of compressed acetylene and oxygen and gave actual demonstrations of cutting and welding, performing the work on a small vertical boiler and upon various steel bars and structural shapes.

Cleveland Steel Tool Company: Punches, dies and couplings of all descriptions were attractively exhibited by this company.

Standardizing of Pipe Flanges for Boilers and Templets for Drilling Same.

The illustrations on pages 179, 180 and 181 show the type and dimensions of standard pipe flanges for boiler work adopted at the recent convention of the International Master Boiler Makers' Association. Fig 1 shows the sizes adopted by the American Society of Mechanical Engineers for pressures up to 125 pounds per square inch. High-pressure screw flanges, suitable for use up to 250 pounds pressure per square inch, are shown in Fig. 2. These differ from the A. S. M. E. standard in size of flange, diameter and pitch circle and size of bolts. In Figs. 3 and 4 are shown the same flanges as to diameter and pitch circle, but with a slight difference in hub diameter and thickness, as these are made of forged steel, while those in Figs. 1 and 2 are of cast iron or ferro steel. Figs. 5 and 6 show the A. S. M. E. standard for riveted pipe. Figs. 11 and 12 show a complete list of saddle nozzles of the Crane Company's standard. These were also adopted as covering fittings not included in the A. S. M. E. standards.

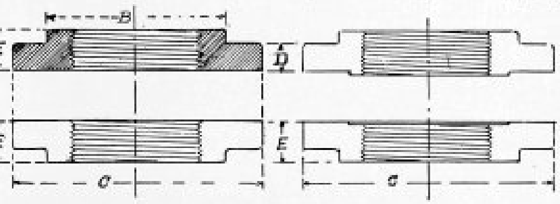
Standard Pipe Flanges — Cast Iron — Screwed

Size A	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20
Diam of Hub B	2	2 3/8	2 11/16	3 1/4	3 11/16	4 1/2	5	5 5/8	6 1/8	6 3/4	7 15/16	9	10 1/16	11 1/16	12 3/8	14 5/8	15 7/8	16 11/16	18	20 1/8	22 5/16
" Flange C	4	4 1/2	5	6	7	7 1/2	8 1/2	9	9 1/2	10	11	12 1/2	13 1/2	15	16	19	21	22 1/4	23 1/2	25	27 1/2
Thickness " D	7/16	1/2	9/16	5/8	11/16	3/4	13/16	13/16	13/16	15/16	1	1 1/16	1 1/8	1 1/8	1 3/16	1 1/4	1 3/8	1 3/8	1 7/16	1 9/16	1 11/16
Depth of Hub E	11/16	11/16	3/4	13/16	15/16	1	1 1/8	1 3/16	1 5/16	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4	1 7/8	2 1/16	2 3/16	2 5/16	2 7/16	2 5/8	2 3/4
Diam Bolt Circle	3	3 3/8	3 7/8	4 3/4	5 1/2	6	7	7 1/2	7 3/4	8 1/2	9 1/2	10 3/4	11 3/4	13 1/4	14 1/4	17	18 3/4	20	21 1/4	22 3/4	25
No. of Bolts	4	4	4	4	4	4	4	4	8	8	8	8	8	12	12	12	12	16	16	16	20
Diam. of "	7/16	7/16	1/2	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8	7/8	1	1	1	1 1/8	1 1/8

High Pressure Pipe Flanges — Cast Iron — Screwed

Size A	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20
Dia. of Hub B	2 5/16	2 1/2	2 7/8	3 5/16	4	4 5/8	5 1/4	5 3/4	6 3/16	6 3/4	7 15/16	9	10 5/8	11 1/16	12 3/8	14 5/8	15 7/8	16 11/16	18	20 1/8	22 5/16
" Flange C	4 1/2	5	6	6 1/2	7 1/2	8 1/4	9	10	10 1/2	11	12 1/2	14	15	16	17 1/2	20	22 1/2	23 1/2	25	27	29 1/2
Depth of Hub E	1	1 1/8	1 1/4	1 3/8	1 7/16	1 9/16	1 5/8	1 3/4	1 13/16	1 7/8	2	2 1/16	2 3/16	2 1/4	2 3/8	2 9/16	2 5/8	2 13/16	2 7/8	3 1/16	3 1/4
Thickness Flange D	11/16	3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 3/16	2 1/4	2 3/8	2 1/2
Dia. Bolt Circle	3 1/4	3 3/4	4 1/2	5	5 7/8	6 5/8	7 1/4	7 7/8	8 1/2	9 1/4	10 5/8	11 7/8	13	14	15 1/4	17 3/4	20	21	22 1/2	24 1/2	26 3/4
No. of Bolts	4	4	4	4	4	8	8	8	8	8	12	12	12	12	16	16	20	20	20	24	24
Dia. " "	1/2	1/2	5/8	5/8	3/4	5/8	5/8	3/4	3/4	3/4	3/4	7/8	7/8	7/8	7/8	7/8	7/8	1	1	1	1 1/8

SUITABLE FOR 250 POUNDS WORKING PRESSURE



FIGS. 1 AND 2.—CAST IRON PIPE FLANGES, SCREWED.

Standard Pipe Flanges — Forged Steel — Screwed

Size A	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14
Diam of Hub B	3 3/8	3 7/8	4 5/16	4 7/8	5 3/8	5 13/16	6 7/16	7 9/16	8 5/8	9 11/16	10 5/8	11 17/16	14 1/8	15 7/16
" Flange C	6	7	7 1/2	8 1/2	9	9 1/4	10	11	12 1/2	13 1/2	15	16	19	21
Thickness " D	5/8	11/16	3/4	13/16	15/16	15/16	15/16	1	1 1/16	1 1/8	1 1/8	1 3/16	1 1/4	1 3/8
Depth of Hub E	1	1 1/16	1 1/8	1 3/16	1 3/16	1 1/4	1 5/16	1 7/16	1 1/2	1 5/8	1 3/4	1 7/8	2 1/16	2 3/16
Actual Bore Dia.	2 1/8	2 1/2	3 1/8	3 5/8	4 1/8	4 5/8	5 1/8	6 3/16	7 1/4	8 1/4	9 3/8	10 5/16	12 5/16	13 1/2
Diam. Bolt Circle	4 3/4	5 1/2	6	7	7 1/2	7 3/4	8 1/2	9 1/2	10 3/4	11 3/4	13 1/4	14 1/4	17	18 3/4
No. of Bolts	4	4	4	4	4	8	8	8	8	8	12	12	12	12
Diam. of Bolts	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8	7/8	1
Size of Tap Drill	2 3/16	2 5/8	3 1/4	3 3/4	4 1/4	4 3/4	5 5/16	6 3/8	7 3/8	8 3/8	9 7/16	10 1/2		

Extra Heavy Forged Steel Pipe Flanges. Screwed

Size A	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16
Diam of Hub B	3 3/8	4 1/16	4 5/16	5 5/16	5 11/16	6 1/4	6 11/16	7 7/8	9 1/8	10 1/8	11 3/16	12 9/16	14 5/8	15 11/16	17 1/16	20 1/4
" Flange C	6 1/2	7 1/2	8 1/4	9	10	10 1/2	11	12 1/2	14	15	16	17 1/2	20	22 1/2	23 1/2	25
Thickness " D	7/8	1	1	1 1/8	1 1/8	1 1/4	1 1/4	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4	1 13/16	2 7/8
Depth of Hub E	1 3/8	1 7/16	1 9/16	1 5/8	1 3/4	1 13/16	1 7/8	2	2 1/16	2 3/16	2 1/4	2 3/8	2 9/16	2 11/16	2 13/16	3 1/16
Dia. Bolt Circle	5	5 7/8	6 5/8	7 1/4	7 7/8	8 1/2	9 1/4	10 5/8	11 7/8	13	14	15 1/4	17 3/4	20	21	22 1/2
No. of Bolts	4	4	8	8	8	8	8	12	12	12	12	16	16	20	20	20
Dia. "	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	7/8	7/8	7/8	7/8	7/8	7/8	1	1

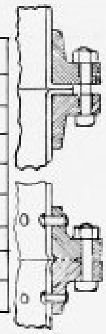
FIGS. 3 AND 4.—FORGED STEEL PIPE FLANGES, SCREWED.

— Flange for Riveted Pipe — Forged Steel —
— A.S.M.E. Standard Diameter and Drilling —

A Size	4	5	6	7	8	9	10	12	14	16	18	20	22	24
B Hub Diameter	4 11/16	5 7/8	6 7/8	7 7/8	8 7/8	9 15/16	10 15/16	12 15/16	15 1/16	17	19 1/16	21 1/16	23 3/16	25 3/16
C Flange "	9	10	11	12 1/2	13 1/2	15	16	19	21	23 1/2	25	27 1/2	29 1/2	32
D Thickness of Flange	9/16	9/16	9/16	9/16	5/8	5/8	11/16	3/4	3/4	3/4	3/4	7/8	7/8	7/8
E Depth of Hub	1 9/16	1 11/16	1 11/16	1 11/16	1 7/8	1 7/8	1 15/16	2	2 3/8	2 3/8	2 3/8	3 1/8	3 1/8	3 1/8
Diam. of Bolt Circle	7 1/2	8 1/2	9 1/2	10 3/4	11 3/4	13 1/4	14 1/4	17	18 3/4	21 1/4	22 3/4	25	27 1/4	29 1/2
No of Bolts	4	8	8	8	8	12	12	12	12	16	16	20	20	20
Size of "	3/4	3/4	3/4	3/4	3/4	3/4	7/8	7/8	1	1	1 1/8	1 1/8	1 1/8	1 1/4

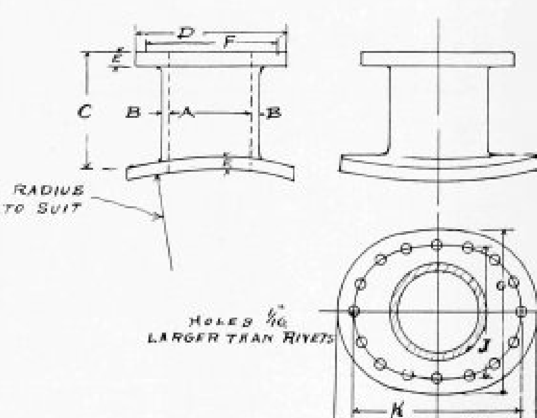
— Extra Heavy: High Hub Flange — Forged Steel —

A Size	4	4 1/2	5	6	7	8	9	10	11	12	14	15	16	18	20
B Hub Diameter	5 3/4	6 1/4	7	7 13/16	9 1/8	10 5/16	11 3/8	12 5/8	13 5/8	14 3/4	16 3/16	17 3/4	18 1/2	20 3/4	22 1/2
C Flange "	10	10 1/2	11	12 1/2	14	15	16	17 1/2	18 3/4	20	22 1/2	23 1/2	25	27	29 1/2
D Thickness of Flange	1 1/8	1 1/4	1 1/4	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 3/4	1 13/16	1 7/8	2	2 1/4
E Depth of Hub	3 1/8	3 1/4	3 1/4	3 3/8	3 3/8	3 1/2	3 5/8	3 3/4	3 7/8	4	4 3/8	4 1/2	4 3/4	5	5 1/2
Diam of Bolt Circle	7 7/8	8 1/2	9 1/4	10 5/8	11 7/8	13	14	15 1/4	16 1/2	17 3/4	20	21	22 1/2	24 1/2	26 3/4
No of Bolts	8	8	8	12	12	12	12	16	16	16	20	20	20	24	24
Size of "	3/4	3/4	3/4	3/4	7/8	7/8	7/8	7/8	7/8	7/8	7/8	1	1	1	1 1/8
Actual Bore Diam	4 3/8	4 7/8	5 7/16	6 1/2	7 1/2	8 1/2	9 1/2	10 5/8	11 5/8	12 5/8	13 7/8	14 7/8	15 7/8	17 7/8	19 7/8



FIGS. 5 AND 6.—FORGED STEEL PIPE FLANGES FOR RIVETED PIPE.

SIZE	A	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28
THICKNESS OF METAL	B	7/16	7/16	7/16	1/2	1/2	1/2	1/2	9/16	5/8	5/8	11/16	3/4	13/16	7/8	1	1 1/8	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8
HIGHT OF NOZZLE	C	7 1/2	7 1/2	7 1/2	7 1/2	7 1/2	8	8	8 1/2	9	9 1/2	10	11	12	13	13 1/2	14	15	15 1/2	16	16 1/2	17
DIA OF FLANGE	D	6	7	7 1/2	8 1/2	9	9 1/4	10	11	12 1/2	13 1/2	15	16	19	21	23 1/2	25	27 1/2	29 1/2	32	34 1/2	36 1/2
THICKNESS OF FLANGE	E	5/8	11/16	3/4	13/16	15/16	15/16	15/16	1	1 1/16	1 1/8	1 1/8	1 3/16	1 1/4	1 3/8	1 7/16	1 9/16	1 5/8	1 11/16	1 7/8	2	2 1/16
DIA OF BOLT CIRCLE	F	4 3/4	5 1/2	6	7	7 1/2	7 3/4	8 1/2	9 1/2	10 3/4	11 3/4	13 1/4	14 1/4	17	18 3/4	21 1/4	22 3/4	25	27 1/4	29 1/2	31 3/4	34
NO OF BOLTS		4	4	4	4	4	8	8	8	8	8	12	12	12	12	16	16	20	20	20	24	28
DIA " "		5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	7/8	7/8	1	1	1 1/8	1 1/8	1 1/4	1 1/4	1 1/4	1 1/4
SHORT DIA SADDLE FLANGE	G	7 1/2	8	8 1/2	9 1/4	9 3/4	10 1/4	10 3/4	12	13 1/4	14 1/8	15 1/2	16 3/4	19	21 1/4	23 1/2	25 3/4	27 3/4	30	32	34 1/2	36 1/2
LONG " " "	H	9 1/2	10 1/2	11	12	12 1/2	12 3/4	13 1/2	14 1/2	16 1/4	17 1/2	19	20	23	25	27 1/2	29	31 1/2	33 1/2	36	38 1/2	40 3/4
SHORT DIA RIVET CIRCLE	J	5 3/8	5 7/8	6 3/8	7	7 1/2	8	8 1/2	9 3/4	10 7/8	11 7/8	13 3/8	14 1/4	16 1/2	18 3/4	21	23 1/4	25 1/4	27 1/2	29 1/2	31 3/4	33 3/4
LONG " " "	K	7 1/4	8 1/4	8 3/4	9 3/4	10 1/4	10 1/2	11 1/4	12 1/4	13 3/4	15	16 1/2	17 1/2	20 1/2	22 1/2	25	26 1/2	29	31	33 1/2	35 3/4	38
DIA OF RIVETS		5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
NO " "		10	10	12	12	14	14	14	16	18	20	22	22	24	26	28	30	32	36	40	40	44



SIZE	A	30	32	34	36	38	40	42	44	46	48	50
	B	1 1/2	1 9/16	1 5/8	1 3/4	1 13/16	1 7/8	2	2 1/16	2 1/8	2 1/4	2 5/16
	C	17 1/2	18	18	18	19	19	19	20	20	20	20
	D	38 3/4	41 1/2	43 1/2	45 3/4	48 1/2	50 1/2	52 3/4	55 1/4	57 1/4	59 1/2	61 3/4
	E	2 1/8	2 3/16	2 1/4	2 3/8	2 7/16	2 9/16	2 5/8	2 11/16	2 11/16	2 3/4	2 13/16
	F	36	38 1/2	40 1/2	42 3/4	45 1/4	47 1/4	49 1/2	51 3/4	53 3/4	56	58 1/4
NO OF BOLTS		28	28	32	32	32	36	36	40	40	44	48
DIA " "		1 3/8	1 3/8	1 3/8	1 3/8	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
	G	38 3/4	41	43	45 1/4	47 1/2	49 1/2	51 3/4	54	56	58 1/2	60 3/4
	H	43	45 1/2	47 1/2	50	52 3/4	54 3/4	57	59 1/2	61 1/2	64	66 1/4
	J	36	38 1/8	40 1/4	42 1/2	44 3/4	46 3/4	49	51 1/2	53 1/4	55 1/2	57 3/4
	K	40 1/4	43	45	47 1/4	50	52	54 1/4	56 1/4	58 1/4	61	63 1/4
DIA OF RIVETS		3/4	3/4	3/4	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
No " "		48	48	52	56	60	60	64	68	72	72	76

STANDARD C.I. SADDLE NOZZLES

FIG. 11.—CAST IRON SADDLE NOZZLE, CRANE COMPANY'S STANDARD.

SIZE	A	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16	18	20	22	24
THICKNESS OF METAL	B		7/16	7/16	1/2	1/2	9/16	9/16	5/8	11/16	11/16	3/4	13/16	13/16	7/8	15/16	1							
HIGHT OF NOZZLE	C		7	7	7½	7½	7½	7½	7½	8	8	8½	9	9½	10	11	12							
DIA OF FLANGE	D		5	6	6½	7½	8¼	9	10	10½	11	12½	4	15	16	17½	20							
THICKNESS OF FLANGE	E		3/4	13/16	7/8	1	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 5/8	1 3/4	1 7/8	2							
BOLT CIRCLE	F		3¾	4½	5	5 7/8	6 5/8	7¼	7 7/8	8½	9¼	10 5/8	11 7/8	13	14	15¼	17¾							
NUMBER OF BOLTS			4	4	4	4	8	8	8	8	8	12	12	12	12	16	16							
DIA OF BOLTS			1/2	5/8	5/8	3/4	5/8	5/8	3/4	3/4	3/4	3/4	7/8	7/8	7/8	7/8	7/8							
SINGLE RIVETED SHORT DIA. SADDLE FLANGE	G		6¾	7	7¾	8¼	9	9½	10	10¾	11¼	12½	13¾	14¾	16	17¼	19½							
SINGLE RIVETED LONG " " "	H		8½	9¼	10¼	11	11¾	12¾	13½	14¼	15	16½	18	19	20¼	21¾	24							
SINGLE RIVETED SHORT DIA. RIVET CIRCLE	J		4 5/8	4 7/8	5½	6 1/8	6¾	7¼	7¾	8 3/8	8 7/8	10 1/8	11¼	12¼	13½	14 5/8	16 7/8							
SINGLE RIVETED LONG " " "	K		6 3/8	7 1/8	8	8¾	9½	10½	11¼	11¾	12½	14	15½	16½	17¾	19	21½							
DOUBLE RIVETED SHORT DIA. SADDLE FLANGE	L		9¾	10	10¾	11¼	12	13	13½	14¼	14¾	16	17¾	18¾	20	21¼	23½							
DOUBLE RIVETED LONG " " "	M		11½	12¼	13¼	14	14¾	16¼	17	17¾	18½	20	22	23	24¼	25¾	28							
DOUBLE RIVETED SHORT DIA. OUTSIDE RIVET CIRCLE	N		7 5/8	7 7/8	8½	9 1/8	9¾	10¾	11¼	11 7/8	12 3/8	13 5/8	15¼	16¼	17½	18 3/8	20 7/8							
DOUBLE RIVETED LONG " " " "	O		9 3/8	10 1/8	11	11¾	12½	14	14¾	15¼	16	17½	19½	20½	21¾	23	25½							
DIA OF RIVETS			5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	3/4	3/4	3/4	3/4	3/4							
NO OF RIVETS SINGLE RIVETED			8	8	10	10	12	12	14	14	14	16	18	20	20	24	24							
" " " DOUBLE "			16	16	20	20	24	24	28	28	28	32	36	40	40	48	48							

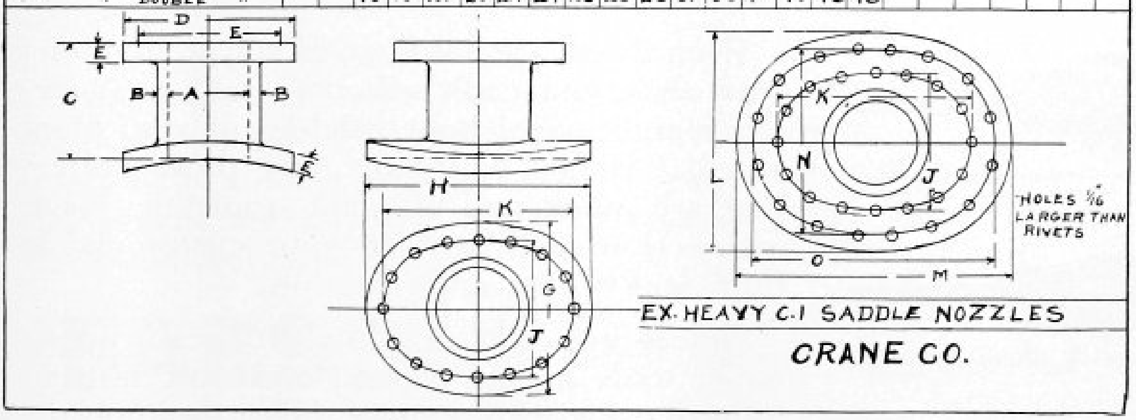


FIG. 12.—EXTRA HEAVY CAST IRON SADDLE NOZZLE.

New Cleveland Boiler Shop.

The D. Connelly Boiler Company, Cleveland, Ohio, who have been established in business on the flats since 1875, have outgrown their present plant, and have recently purchased a tract of 6 acres, located on East Collamer avenue and the Nickel Plate Railway, and have awarded contracts for a new plant. The main building will be used as a boiler shop, and for the present will be 140 feet wide and 200 feet long. It will have a center aisle 60 feet wide and 32 feet from the floor to the top of the rail for the crane runway. The crane covering the center of this aisle will be designed to lift 40 tons. The two sides aisles will each be 40 feet wide and 22 feet from the floor to the rail for the crane runway. The cranes in these aisles will be designed to lift 10 tons. At one end of this building will be a tower for two hydraulic riveters, of sufficient height so that a 30-foot shell can be lifted over the stake of an 18-foot 6-inch riveter. Two 25-ton hydraulic cranes will be installed in the riveting tower. There will also be another building, 50 feet by 200 feet and 26 feet high. Eighty feet at one end will be walled off and used as the power house, the other 120 feet will be the forge and flanging shop. Both of these buildings will be of heavy steel construction, the walls to be of brick for 5 feet above grade, and the balance glass. There will be another brick building, 30 feet by 40 feet, and two stories high, to be used as a pattern storeroom. Another building, 32 feet by 32 feet, and two stories high, containing a fireproof vault, will be used for the office and drafting room. There will be one railroad switch into the center of the main building, and another along the side of the power house and forge shop. The company expects to occupy only one of the four buildings at its old location, leaving enough small machinery to take care of its down-town repair business; all the large machinery, including the hydraulic riveter, universal hydraulic flanging machine, spinning machine, large punches, rolls, radial drills, etc., will be moved into the new plant, which it is expected will be ready about Dec. 1. When completed this new plant is expected to be one of the most modern plants of its kind in the United States. The buildings will contain a modern lavatory and heating system.

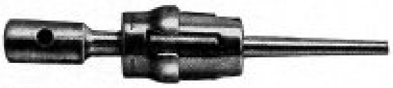
This business was established in a small way in 1875 by Daniel Connelly, who continued as proprietor until 1905, when he formed a stock company and admitted his two sons as partners. The main buildings are so designed that at any time they may be enlarged to a length of 500 feet.

General Foremen's Association.

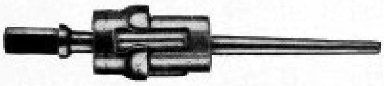
At the Annual Convention of the International Railway General Foremen's Association, held in Cincinnati, Ohio, May 3, 4, 5, 6 and 7, the following officers were elected for the ensuing year:

President—C. H. Voges, G. F., C. C. C. & St. L. Ry., Bellefontaine, Ohio; First Vice-President—T. F. Griffin, G. F., C. C. C. & St. L. Ry., Indianapolis, Ind.; Second Vice-President—J. A. Boyden, G. F., Erie R. R., Cleveland, Ohio; Third Vice-President—E. A. Murray, M. M., C. & O. Ry., Lexington, Ky.; Fourth Vice-President—H. D. Kelly, G. F., C. & N. W. Ry., Chicago, Ill.; Secretary and Treasurer—Luther H. Bryan, G. F., D. & I. R. R. R., Two Harbors, Minn. Executive Committee—E. F. Fay, Shop Supt. U. P. Ry., Cheyenne, Wyo., chairman; Luther H. Bryan, G. F., D. & I. R. R. R., Two Harbors, Minn., secretary; T. J. Finerty, G. F. I. & G. N. Ry., Spring, Tex.; F. C. Pickard, Ass't. M. M., C. H. & D Ry., Indianapolis, Ind.; Wm. Hall, G. F., C. & N. W. Ry., Escanaba, Mich.

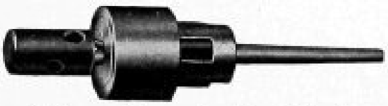
The next convention will be held in Chicago.



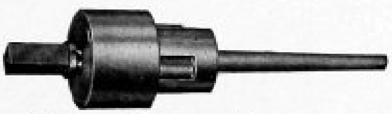
"Boss" Roller Expander (Hand Use)



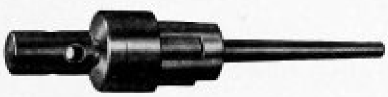
Boss" Roller Expander (Self-Feeder)



Universal Expander (Hand Use)



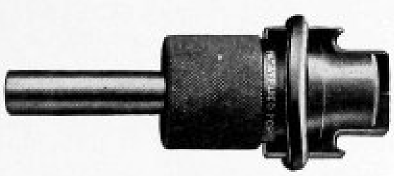
Universal Expander (Self-Feeder)



Removable Collar Expander (Hand Use)

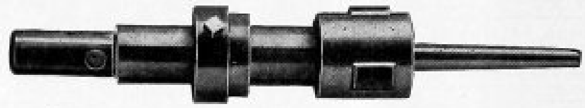
Removable Collar Expander (Self-Feeder)

Rapid Beading Expander



Rapid Beader Tool

Improved Sectional Expander



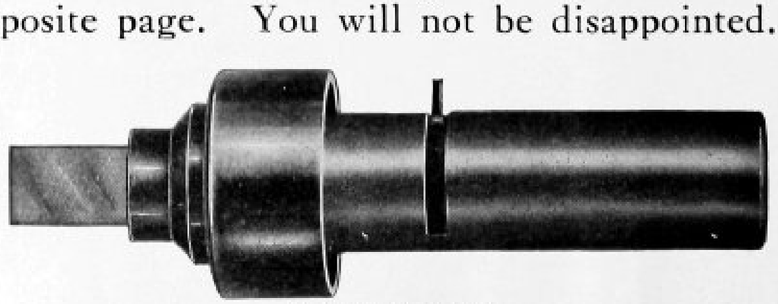
Arch Flue Expander

IT PAYS TO USE FAESSLER BOILER MAKERS' TOOLS

Even if you are not keen to cut production or repair costs, you can't afford to take chances when the reputation of your product or your plant is at stake. Hence you want only those boiler tools that are quick and efficient—tools that save your men's time and protect your customers' boilers from leaky tube ends later on.

Unless you can absolutely depend upon your boiler tools to cut, expand and bead tubes to conform to every requirement, unless the tools do their work uniformly well and quickly, and unless accurately made from the right steel to last under severe service, they would be more expensive than Faessler tools even if Faessler's cost twice as much. Considering this, isn't it better to pass up penny savings at the expense of dollar losses?

The price of Faessler tools is only a little more than for the cheapest, but they embody the best design, material and workmanship that money can buy. They are the product of a firm that is, and always has been, the recognized leader in its line. It is up to you to protect yourself by rejecting subtitutes. Take advantage of the offer on the opposite page. You will not be disappointed.



"Perfect" Flue Cutter

The Boiler Maker

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Federal Inspection of Locomotive Boilers.

For several months there has been pending in Congress a bill intended to provide Federal inspection of locomotive boilers. This measure was thoroughly discussed at the recent convention of the International Master Boiler Makers' Association, with the result that the association passed resolutions utterly condemning the bill as being absurdly impractical and detrimental to the interests of both the traveling public and the railroads. The general attitude of railroad men towards Federal locomotive boiler inspection is that such inspection would be all right provided the proper kind of bill was passed; for the government, however, to attempt to usurp the responsibilities and duties of the railroads without adequate means to insure that the inspection would be better than that at present maintained by the railroads, is absurd. We have frequently commented upon the thorough and careful inspection of locomotive boilers performed by railroad companies, the excellent results of which are evidenced by the extremely small percentage of explosions due to defects in material or workmanship. Federal supervision of the inspection carried out by the railroad companies might be feasible and advantageous, as it has proved in at least two States; but measures as absurd and impractical as the one now before Congress, fostered by politicians, are sure to be laughed out of court by all practical mechanics.

Improving the Work of the Boiler Makers' Association.

It is encouraging to note that at the recent convention of master boiler makers all records of the association were broken as regards attendance and increase of membership. While the officers and members are to be congratulated upon this splendid record, it should not be inferred that all of the work of the association was equally good. In his annual address, the president pointed out very emphatically that the progress of the work during the past year had been distinctly disappointing, and that it was due largely to the lack of interest on the part of individual members. If every member of the association thoroughly realized that his own lack of interest in the work is seriously retarding the growth and progress of the association, we believe that a new impetus would be given to the life of this important organization. As a rule, boiler makers are anything but shirkers, and it is undoubtedly due more to a lack of the appreciation of personal responsibility than to any unwillingness to work that the results which should be expected are not achieved.

So far, most of the work of the association has been largely confined to committee reports, and, due to the fact that members of such committees are widely separated, and cannot, therefore, work together, it has been found extremely difficult in many cases to make up a comprehensive and complete committee report. This, however, is an evil which can be corrected very largely by awakening the interest of individual members of the committees and bringing them to a realization of the responsibility which has been imposed upon them by their appointment to the committee. The action of the association in voting that hereafter all individual reports submitted by members of committees should be read at the convention and printed in the proceedings, together with the chairman's report, is undoubtedly a step in the right direction, and will serve to provide more subject matter for discussion. It is seldom possible for all the members of a committee to agree regarding a certain subject, and as in such cases there are usually two sides to the question it would probably be advantageous to have the committee present two reports—one a majority and one a minority report. In this way we believe that the committee work will be improved and made more valuable each year. At the same time there is another method by which valuable information can be presented for discussion at the annual conventions, and that is by means of individual papers contributed either by members or non-members who are intimately associated with the problems confronting boiler makers. The presentation of a greater number of such papers we believe would add much to the value of the proceedings of the association, and, at the same time, provide a wider variety of subjects for discussion. Where such papers are carefully prepared and printed in advance of the meetings, it is unnecessary to take up much time at the convention by the reading of the papers, as they can be read in abstract form and the time thus gained can be utilized for discussion. Those who attended the convention this year, and listened to Mr. McBain's very interesting and instructive paper on "Expansion of Locomotive Boilers," will undoubtedly agree that more individual papers of this sort would be of great value to the association.

COMMUNICATIONS.

A Pneumatic Holding-On Device.

EDITOR THE BOILER MAKER:

After reading "Experimenter's" letter on page 149 of the May issue of THE BOILER MAKER, and after making a careful study of the sketch and drawings of his holder-on, it seems to me that the trouble is solely an imaginary one, in short, the device appears to be all right. If the machine is as good as it looks in the drawings, is free from leakage, etc., I see no reason why it should not give entire satisfaction with the 90 pounds per square inch air pressure referred to as being available.

It is possible that the 3 inch piston upon which the air acts, leaks at its contact surface with the walls of the cylinder. If this is so, then of course the full benefit of the 90 pounds air pressure will not be realized. But if it is pressure tight then $3^2 \times .7854 \times 90 = 636+$ pounds will be the total pressure exerted against the rivet head holding it in place. If that pressure is not enough as proved by practice, then either increase the pressure or increase the area of the piston upon which the pressure is to act. Making the piston 4 inches, thus increasing the diameter by 1 inch will make quite a difference in the resulting holding-on force thus:— $4^2 \times .7854 \times 90 = 1128+$ pounds total force.

It is just possible that I have overlooked something in the make-up of the device, or that I am reasoning from wrong premises. If so I would like to learn of it from some other readers who may have opinions to express.

Scranton, Pa. CHARLES J. MASON.

Dangerous Oxy-Acetylene Apparatus.

EDITOR THE BOILER MAKER:

Our attention has just been called to the article "Dangerous Oxy-Acetylene Apparatus" in your May issue. As this article has already been severely criticised in the "Iron Age," it is probably unnecessary for us to enlarge on it to very great extent. However, it creates a wrong impression and we believe an injustice to ourselves, and believe that some statement should be made regarding it. Although the generation of acetylene gas by the water feed or recession process may not be as desirable as the carbide feed, yet, there is apparatus by which a very high grade of acetylene gas is generated. This also makes the portable apparatus possible which can be used in a great many instances to advantage where portability is necessary. The cost of compressed gas is very high when used in such quantities as are necessary for heavy welding and this brings the need of an apparatus for generating this gas on the spot. Although we can supply the compressed gas and likewise the apparatus for compressing same, yet it is quite an expensive installation. The same may be said of the oxygen.

For large consumers we recommend this installation, but for many smaller ones the cost would be prohibitive and for them the lower-priced outfit for generating under compression is better adapted. For this purpose, we have perfected this portable apparatus to a high stage of efficiency.

There is not as much danger in handling the portable apparatus as there is in the portable steam engine and it does not require as much attention. As we have manufactured several different types of apparatus for some time past we are in a position to know something about the industry. Having had solicitations from different firms in Europe desiring to sell our apparatus we naturally consider that the European market is still alive. OXY-CARBI COMPANY.

Problem for Our Readers.

EDITOR THE BOILER MAKER:

I would like to get the opinion of the readers of your valuable paper on the following questions:

1. What is the proper sized blow-off for a locomotive boiler weighing 90 tons?

2. What is the rule for figuring the horsepower of a locomotive boiler?

3. A locomotive with a self-cleaning front end does not steam well. Should the petticoat pipe be raised and the sleeve lowered, or should the petticoat pipe be lowered and the sleeve raised to increase the draft?

4. Does the diaphragm plate control the burning of the fire and should it be raised to cause the fire to burn near the door?

5. In testing a locomotive boiler after repairs, should the test pressure be one-third larger than the working steam pressure? A READER.

NOTICE.

A New Book of Boiler Rules and Formulæ.

At the recent annual convention of the International Master Boiler Makers' Association arrangements were made through the kindness of a good friend of the organization whereby the Rules and Formulæ prepared a year ago by Charles P. Patrick and his associates on a committee and adopted at the Louisville convention, will soon be published in book form and of convenient size to be carried in a man's pocket for ready reference. Each member of the Association whose dues are paid to April 1, 1911, will receive a copy of the publication without expense. To all others the book will be sold for the benefit of the Association at $1 per copy, payable in advance. It will be copyrighted so as to protect the association from infringement on all rights reserved. Orders for it should be sent to the Secretary of the Association, Harry D. Vought, 95 Liberty street, New York City, and that these may be promptly filled as well as that the necessary number to be printed to meet the demand may be determined without delay, orders should be sent in at once.

TECHNICAL PUBLICATION.

Purchasing Agents' Buying List and Railway Supply Index. Size, 9 by 11¾ inches. Pages, 540. Chicago, 1910: Buyers' Index Company. Price, $6.

This is the first volume of a new annual publication for the railway official which aims to index and cross index in a very complete manner all supplies manufactured for the engineering and mechanical departments of railroads and to list the names of dealers and all manufacturers of such supplies. The Index is comprised of four sections, as follows: Section No. 1 is an alphabetical index of all railway supplies listing all manufacturers and dealers in each supply. Section No. 2 is an alphabetical list of trade names of railroad supplies. Section No. 3 is an alphabetical list of concerns listed in Section No. 1. Section No. 4 is a catalogue or advertising section. The book is such a complete index that railway officials and purchasing agents will undoubtedly find it of great value. Advertisers and non-advertisers have been treated alike in the book, so that the reader can be fairly certain that the work is as complete as it is possible to make a first edition of such an index.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—How do you determine the thickness of the firebox sheets of a vertical boiler, and also the spacing and size of stay-bolts?

A. In designing the firebox of a vertical boiler and the staying for same, there are three variables, namely, the thickness of plate, number of staybolts and size of staybolts. It is necessary to assume a value for one of these variables in order to determine the other two. The firebox sheet is considered as if it were a flat sheet and derived no strength from the fact that it is a cylindrical shell subject to external pressure. It is usual to assume arbitrarily the thickness of the firebox sheet proportioning this to the size of boiler and steam pressure carried according to the judgment of the designer. The size and pitch of stay-bolts are then figured from the following formula:

$$p^2 = \frac{115 \times t^2}{P},$$

whre p = pitch of staybolts in inches; t = thickness of firebox sheet in sixteenths of an inch; P = working steam pressure in pounds per square inch. Having determined the pitch of staybolts, the size can be figured by making the sectional area of the bolt large enough to resist the total stress on it, due to the steam pressure acting on the area which it must support. This area is of course equal to the square of the pitch. The unit stress on the staybolts should not exceed 6,000 pounds per square inch.

Q.—What steam space should be allowed in a vertical boiler?

A. The steam space of any boiler should be proportioned to the rate of steam consumption by the engine with which it is to be operated. This is frequently done by making the capacity of the steam space in the boiler equal to the volume of steam consumed by the engine in 20 seconds. This gives good results for high-speed engines; with low-speed engines the steam space should be larger.

Q.—What size safety valve should be used for oil-burning boilers?

A. The capacity of any safety valve should be such that when the valve is lifted by the steam pressure at which it is designed to operate, the effective opening shall be sufficient to discharge all the steam that can be generated by the boiler when working at its full capacity. A common rule is to make the area of the effective opening equal to 70 times the weight of steam discharged per second divided by the absolute pressure on the boiler; that is, the pressure as read from the gage plus 14.7. In this formula, the weight of steam discharged per second must be equal to the weight of steam which the boiler is capable of generating per second when urged to its full capacity. The size of valve will, therefore, depend entirely upon the evaporative power of the boiler, and is usually determined from the number of pounds of water evaporated per pound of fuel burned, data which should be available from the design of the boiler.

Q.—How much upward deflection would there be in the centre of a 3-inch by 20-foot boiler tube under 4 feet of water, the tube being expanded in the heads or the ends of the tube being closed? It seems to me that the tube would have a tendency to float, but, as it would be fastened to the heads, the tendency would be for it to rise in the centre or deflect upwards when under water and sag in th centre when the boiler would be empty. Would a 3-inch tube 20 feet long be too small a diameter to use and cause excessive sagging? What causes the bottom tubes to rise or arch more than the top ones?

A.—The tube would have a tendency to sink rather than to float, as can be readily seen from the following:

Considering a section of the tube, 1 foot long, under the conditions imposed; that is, that the ends are plugged up and the tube immersed in water. In order for a body to float in water it is necessary that the weight of the water which it displaces shall be greater than the weight of the body itself. The weight of a standard 3-inch boiler tube, 12 B. W. G. thick, is 3.33 pounds per foot; that is, our section of tube 1 foot long would weigh 3.33 pounds, and, unles the weight of the volume of water which this tube displaces exceeds 3.33 pounds, the tube will sink rather than float. The transverse area of a 3-inch tube is 7.07 square inches, and multiplying this by the length which we have taken as 1 foot, or 12 inches, we find the volume of the 1 foot section of tube to be 84.84 cubic inches. Now 1 cubic foot of water at ordinary temperature weighs 62.43 pounds, and since there are 1,728 cubic inches in a cubic foot the weight of the water displaced by a section of 3-inch tube 1 foot long would be $\dfrac{64.43 \times 84.84}{1728} = 3.06$ pounds, which, you will note, is less than the weight of the tube itself. Therefore, the bouyancy of the water is not sufficient to cause the tube to float, and there could be no upward force due to this cause tending to make the tube rise in the center. The depth to which the tube is immersed has nothing to do with this problem. It is true that the pressure of water increases as the depth increases, but the diameter of the tube is so small compared with the depth to which it is immersed that for practical purposes the pressure can be considered uniform all around the tube, and there will be no unbalanced force, or, at most, a very slight unbalanced force tending to force the tube upwards. This would not be greater than the excess weight of the tube over the buoyancy of the water.

The above reasoning will hold true also for a 3½-inch tube, since the weight per foot of a 3½-inch tube is 4.28 pounds, and the weight of the water displaced by a section of 3½-inch tube 1 foot long is only 4.16 pounds.

As to your question, whether a 3-inch tube 20 feet long would be too small in diameter; smaller tubes than that have been used of longer length. As, for instance, in the Mallet articulated compound locomotives built last year by the Baldwin Locomotive Works for the Southern Pacific Company, the tubes are 2¼ inches diameter and 21 feet long. These tubes apparently are satisfactory and undoubtedly you would be safe in using a 3-inch tube 20 feet long. It is true that when tubes as long as this are used they have a tendency to sag when water is out of the boiler, and they are frequently found to rise in the middle after the boiler has been under steam. This upward movement, however, is not due to the buoyancy of the water but is usually attributed to the fact that the top of the tube is subject to more intense heat than the bottom, and, therefore, the metal in the top of the tube expands more than the metal in the bottom, and, consequently, causes the tubes to arch upwards in the middle. The reason why the bottom tubes do this more than the top ones is sometimes stated to be due to the fact that the bottom tubes receive more heat than the top ones. This appears reasonable and is undoubtedly the true cause.

PERSONAL.

H. A. LINTON, formerly with Fuller Bros. Company, New York City, has resigned his position and accepted a position with Joseph T. Ryerson & Son.

ALBERT B. BOWMAN, 720 North Second street, St. Louis, Mo., has recently been appointed special sales representative of the Pawling & Harnsichfeger Company, Milwaukee, Wis., designers and builders of electric cranes and hoists.

GEORGE A. KINZEL, formerly at Lafayette, Ind., has been appointed foreman boiler maker of the Denver & Rio Grande shops at Salt Lake City, Utah.

H. S. WHITE, formerly Assistant Manager of Sales of the National Tube Company, Pittsburg Pa., has accepted a position as General Manager of the Detroit Seamless Steel Tubes Company, Detroit, Mich.

JOHN H. SMYTHE, formerly Foreman Boiler Maker of the American Locomotive Company, Pittsburg Shops, has accepted a position with the Parkesburg Iron Company, Parkesburg, Pa., as Boiler Expert.

N. J. FITZHENRY has resigned his position as Chief Inspector of the Bethlehem Steel Company, South Bethlehem, Pa., to become Superintendent of the Wm. H. Atkinson Company, Steel Manufacturers, 74th street and Hudson River, Hoboken, N. J.

HENRY F. GILG, formerly with the Sligo Iron & Steel Company became associated with the Carter Iron Company on June 1st. Mr. Gilg's headquarters are at Pittsburg.

J. A. SHAY has succeeded H. F. Gilg as sales manager of the Carter Iron Company, Pittsburg, Pa.

B. F. THROCKMORTON has been made foreman of the boiler shop of the Waterous Engine Works Company, Brantford, Ontario, Can.

OBITUARY.

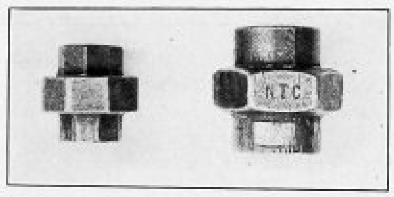
T. C. Best, founder and former president of the Master Steam Boiler Makers' Association, died in Chicago, Ill., April 28. Mr. Best was born in Rock Island, Ill., and began his apprenticeship work at Moline, Ill. After serving his apprenticeship he worked for about ten years as a journeyman boiler maker in the States of Illinois, Iowa, Nebraska and Minnesota. He had charge of the Murray Iron Works at Burlington, Ia., for four years, and was subsequently connected with the Marine Iron Works, of Chicago, Ill.; S. Freeman & Son, Racine, Wis.; Frazier & Chalmers, Chicago, Ill.; National Boiler Works' Shop, Chicago, Ill., and the Northwestern Railroad shops, Chicago, Ill. The latter position he resigned in 1902, in order to take up the work of forming the Master Steam Boiler Makers' Association. It was in connection with this association that Mr. Best became widely known among the boiler makers throughout the country, as he was its first president, and for several years editor and publisher of its official organ *Motive Power*. During the past four years Mr. Best has been associated with Joseph T. Ryerson & Son as consulting engineer.

T. C. BEST.

ENGINEERING SPECIALTIES.

Test of Kewanee Pipe Unions.

The illustration shows two Kewanee pipe unions manufactured by the National Tube Company, Pittsburg, Pa. One is a 1-inch octagon union, and the other a 1½-inch round union. These two unions were taken from stock with no particular effort at selection and were tested in the following manner: Each union was connected by means of a nipple valve, and nipple to a steam line. Into the other end of each union was screwed a nipple on the outer end of which was another valve. The union connection was then tightened with an ordinary wrench, steam pressure was admitted by means of a valve next to the main, the outer valve was opened to blow out the air, and then closed. Close scrutiny was given the union to be sure that there was no leakage of steam; the steam pressure was then shut off, the outer valve opened to blow out the steam, and the union ring was unscrewed entirely from the brass end. This operation was repeated one

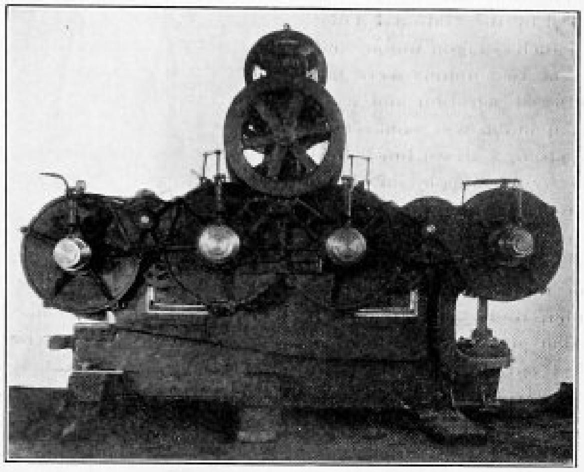


thousand times on each of the unions, and, it is claimed that during the entire time neither union showed the slightest sign of leakage of steam. After the completion of this test, each union was subjested to the same test which is received by all new unions, namely: that of 110 pounds air pressure under water, and, it is claimed, that both unions were also absolutely tight during this test.

The foregoing tests were made to show the durability of the gasketless type of union with a brass-to-iron joint. Where gaskets are used with unions the disconnecting and reconnecting of the joint an indefinite number of times means that a new gasket must be cut and fitted frequently, involving not only delay but also the feature of an uncertain joint, whereas a good joint can be obtained with the gasketless type with no trouble whatever no matter how many times it has previously been disconnected and reconnected. The brass-to-iron joint, which is a feature of the Kewanee union, is claimed to eliminate corrosion which frequently occurs with an iron-to-iron joint.

Universal Shear for Channels, Angles, and Plates.

The need in ship yards for a machine to cut square or mitred the various channels and angles required for ship building purposes has been met by the machine shown herewith. While especially built for the Marine Department of the Maryland Steel Company, Sparrows Point, Maryland, this machine is intended for any class of iron workers. It is provided with a coping attachment at one end of the machine; a plate shear at the other; and two angle shears, operating at an angle of 45 inches in the center of the frame. The latter have a capacity for cutting up to 15 inches by ¾ inch channels, and 6 inches by 6 inches by 1 inch or 8 inches by 8 inches by ¾-inch angles. The plate shear has a capacity for 1 inch material. Each shear is controlled by its own clutch, and the machine may be operated by different groups of men all working at the same time, and without interfering with each other. The frame, plunger, pendulums, clutches, and all parts subject to shock are made of semi-steel castings. Hammered steel shafts containing .4 to .5 carbon are used for the shafts, and the question of lubrication has been given special consideration. The gears are provided with long sleeve hubs, and the covers which protect the gears



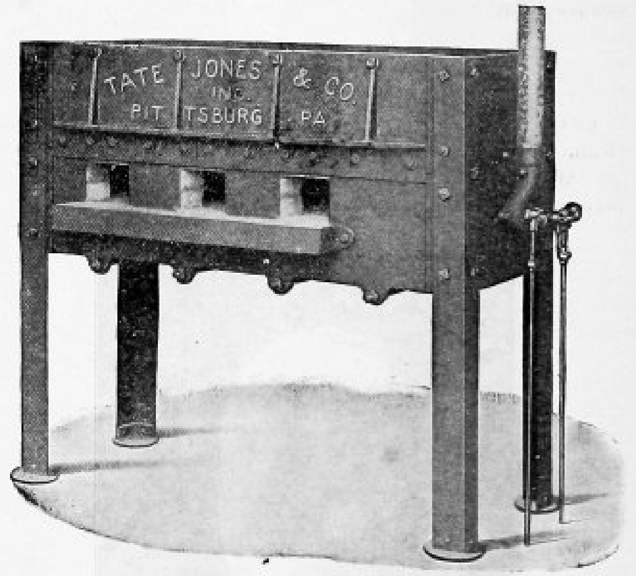
are bored to receive them. The gears in turn support the shafts, which have bearing surfaces throughout their entire length. A patent stop motion is used, which automatically throws out the clutch on each shear when it reaches its highest point. For the coping attachment, which may also be used for punching, the stop mechanism is adjustable so that the plunger may be stopped in any point of its down stroke. It will be noted by the cut that the plates for supporting the angles or channels while being cut are so placed that they are out of the way of plates while being sheared as the latter pass under them. The machine in question weighs about 23 tons. It is driven by a 25 horsepower electric motor, and is manufacturered by the Covington Machine Company, Covington, Virginia and New York.

Oil Furnace for Heating Iron and Steel in Forging.

The Kirkwood Oil Burning Furnace which is made by Tate, Jones & Co., engineers and manufacturers, of Pittsburg, Pa., is uesd in heating iron and steel for forging, etc., in plants where oil is not regularly used as fuel. The burner is different from any of the other oil burners on the market in that the oil and compressed air for atomizing are controlled by one lever, the proportions being determined by tests at the factory before the furnace is shipped. Once determined this burner is so adjusted that this ratio of air to oil is fixed and is not left to the judgment of the operator. Since the proper atomization of the oil is the vital point in the successful oil burner, this arrangement is of great value and is claimed to prevent the troubles which frequently occur with oil burners through ignorant or careless operators.

The air for forcing the oil to the burner under pressure and for atomizing and oxydizing it, is supplied by a small rotary blower which is mounted on the floor near the furnace and may be driven by an electric motor or other source of power. About 60 cubic feet of air compressed to 25 pounds is used for atomizing the oil; the pressure at the burner being about 20 pounds. The portion of the air blast which furnishes the necessary oxygen for proper combustion is so regulated, by the lever just referred to, that the pressure at the burner is from two to four ounces. The regulation of this pressure varies the fire from an oxydizing flame to a strong reducing heat. This gives the operator the exact heat wanted at a moment's notice. The burner can be cleaned without disconnecting it from furnace and is claimed to be nearly noiseless in its operation.

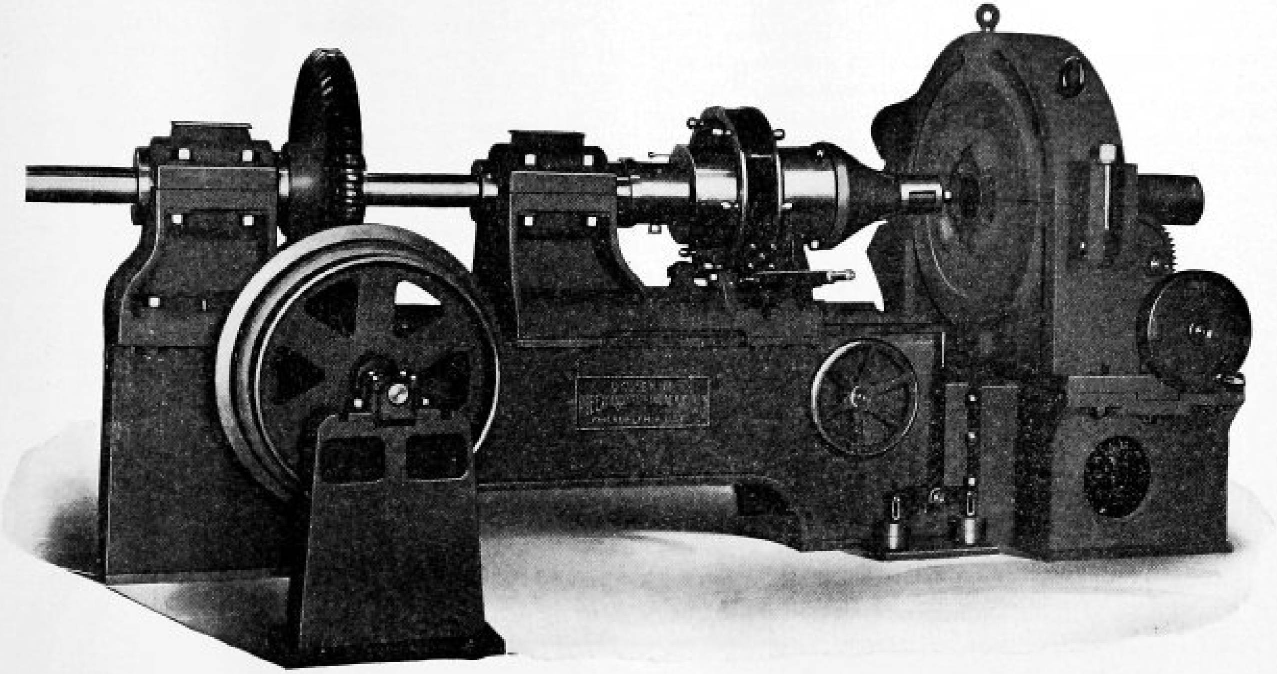
A steam jet or the regular shop compressed air supply can be used for atomizing the oil if desired. In the latter case a reducing valve is necessary to cut down the pressure to the proper amount for atomizing. This valve is supplied with the furnace if so desired. The burner is set up under an inclined arch of fire clay at the center of the furnace, the inclination being from the burner downward so that the products of combustion travel down the arch completely encircling and filling the inside of the furnace and escaping through two vents in the upper corners on the same side as the burners. This is said to give equal distribution of the heat through every part of the furnace. The furnace is



lined throughout with the best quality of fire brick, carefully laid, and between the fire brick and the outside metal wall a thick layer of asbestos is placed. This heat insulation saves fuel and prevents the air in the neighborhood of the furnaces from becoming unpleasantly warm.

The oil for this furnace is carried in a tank attached to the side, the tank being filled from a barrel when necessary by a small rotary hand pump. For plants having an oil fuel supply the tank is not necessary.

Many advantages are claimed for the Kirkwood oil furnace as compared with coal furnaces. It gives a very intense and evenly distributed heat and can be regulated with great exactness. The time required to get the furnace to the proper temperature is very much less than where coal is used for heating. When once the desired temperature is reached it is maintained without further regulation so that the attention of the operator can be given entirely to his work. In actual tests the amount of work which can be turned out with one of these furnaces is claimed to be from 25 to 35 percent greater then when using coal for fuel. In addition to the above advantages there is the improvement in shop conditions secured by doing away with the coal dust and ashes and the smoke from the coal fire. There is practically no smoke from the oil fire.



The Lovekin Pipe-Expanding Machine.

The Lovekin Pipe Expanding & Flanging Machine Company of Philadelphia, Pa., have on the market a machine capable of expanding pipe ranging from 2 to 16 inches diameter into flanges according to a special method known as the Lovekin method. In this method grooves or tool marks are made in the bore of the flange and the pipe is expanded into the flange by a process of cold rolling on its inner surface. After the pipe is expanded to meet the flange, the rolling is continued until the pipe metal is "flowed" or extruded into the grooves or tool marks in the flange. The tremendous pressure required in this process increases the circumference of the pipe, leaving it in a state of compression of the flange or other containing body. It is claimed that in this way the union between the metals is so close as to make the pipe and flange practically one. The pipe remains of a nearly uniform thickness throughout its entire length, and, it is claimed, that the quality of the metal itself is greatly improved, due to the cold rolling, tests having showed that cold rolling increases the tensile strength of the metal about 15 percent. Almost simultaneous with the process of extrusion the end of the pipe is flared off by a second set of floating rollers in the taper head of the Lovekin tool after which it is automotically faced off with the surface of the flange making a smooth even joint.

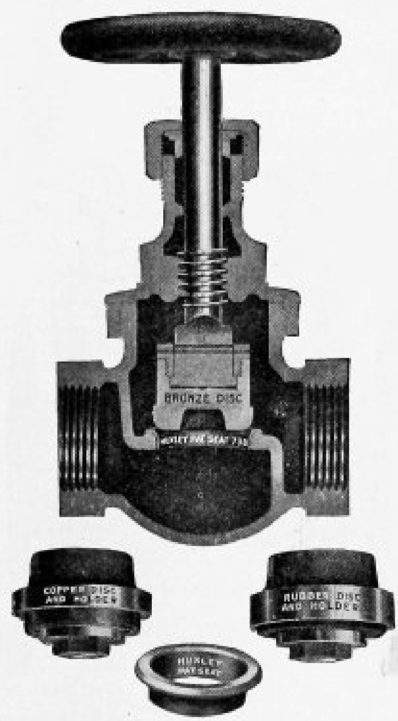
It is claimed that a pipe flanged by the Lovekin process is strongest at the flange and is, therefore, best adapted to resist vibration and corrosion, should they occur. In the older methods of threading the pipe into flanges, the thickness of the pipe at the joint is reduced by at least 30 percent, making it the weakest point for resisting vibration, Furthermore, corrosion is easily started in the threaded joint. Other methods of securing pipe flanges, such as peaning by a hand hammer, as is frequently done on copper work, are also open to the foregoing objections, since uniformity in the thickness of the pipe is destroyed and it is left with a rough internal surface that is frequently flaked.

Where riveted flanges were formerly used the rivets partly obstructed the pipe at the flange, but the Lovekin method, by expanding the pipe, actually increases its diameter at the flange, thereby reducing the pressure at that point.

The machine shown in the illustration occupies a floor space 10 feet 9 inches by 6 feet 8 inches and weighs 13,000 pounds.

Huxley Bronze Globe Valve.

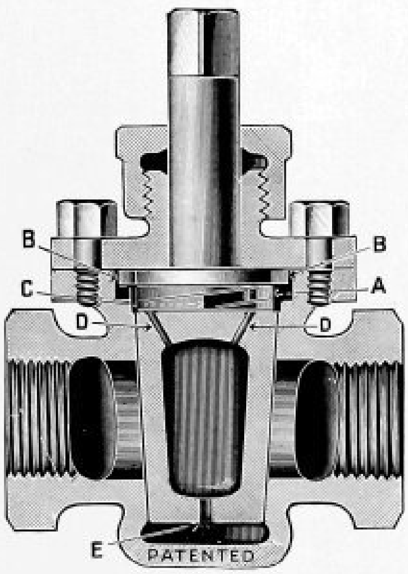
The Nelson Valve Company, Philadelphia, Pa., have on the market a bronze globe valve in which the seat is renewable. For this reason whenever the valve leaks it is not necessary to regrind the valve but to simply take out the seat and put in a new one, which can be done easily and rapidly. After this valve has been placed on the pipe it is, therefore, never necessary to remove it on account of leakage, since by means of a



common wrench access can be obtained to the seat for renewal. The shell of the Huxley seat is tapered and fits the valve seat tightly. If the Huxley seat becomes cut it is simply necessary to take it out and slip in a new one. The disc holder will fit any kind of a disc, either brass, bronze, copper, white metal, rubber or leather. The valve shown in the illustration is fitted with a bronze disc.

Homestead Valves.

Homestead valves, manufactured by the Homestead Valve Manufacturing Company, Pittsburg, Pa., are being largely used as blow-off valves on stationary, marine and locomotive boilers. The form of construction which is shown in the sectional view is particularly suitable for blow-off service.



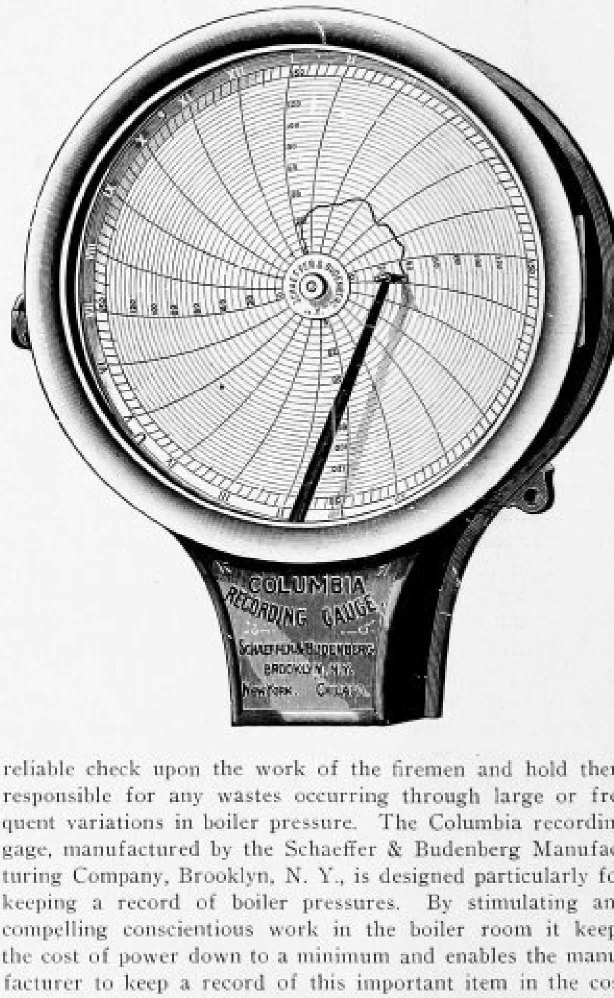
The opening being straight through the valve allows a clear passage for the impurities which have collected in the boiler and must be relieved. In passing through this valve, the sediment and grit are not forced against the seat as in the case of some type of valve, but they pass through the valve without coming in contact with the seat, thus relieving it of all wear from this source. The valve opens or closes with just a quarter turn. By the patent device which can be seen

in the sectional view, the plug is limited to a quarter turn and locked tightly when closed. In opening, it is claimed, a slight jar releases the plug, which can then be turned very easily.

The illustrations also show exterior and interior views of the Homestead straightway valve flanged. The valves are made either of brass or iron or of iron bodies with brass plugs, and they can be made with special connections for unusual service. They are useful not only as boiler blow-off valves, but are used as well for high-pressure water, air or steam service of every kind, where pressures from 150 to 5,000 pounds per square inch are used.

The Columbia Recording Gage.

Uneven boiler pressure means waste of coal and unsatisfactory delivery of power to the operating room. Unnecessary variation of pressure also shortens the life of a boiler. Since the control of the boiler pressure rests entirely with the men in charge of the boilers, there is probably no better way to secure uniform pressure than by having a means of keeping a record of the boiler pressure, so that not only can the firemen see at a glance what kind of work they are doing, but also the superintendent or owner of the plant can have a



reliable check upon the work of the firemen and hold them responsible for any wastes occurring through large or frequent variations in boiler pressure. The Columbia recording gage, manufactured by the Schaeffer & Budenberg Manufacturing Company, Brooklyn, N. Y., is designed particularly for keeping a record of boiler pressures. By stimulating and compelling conscientious work in the boiler room it keeps the cost of power down to a minimum and enables the manufacturer to keep a record of this important item in the cost of production.

The Columbia recording gages can be used not only for recording boiler pressure, but also for recording the flow and distribution of gas through the mains in the gas industry; for recording the height of water in tanks; for recording fan pressures in mines; or, in brief, for any service wherever it is desired to know that pressures and volumes of steam, water, air, gas, ammonia, acid or sulphite are properly maintained.

Change of Address.

The Ingersoll-Rand Company, New York, announces the removal of its Chicago office from the Old Colony building to the Peoples Gas building.

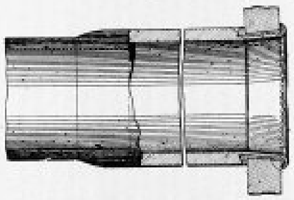
SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

949,621. FLUE-POINT AND ITS ATTACHMENT TO FLUE-SHEETS. CHARLES S. COLEMAN, OF SPOKANE, WASH., ASSIGNOR TO RAILWAY IMPROVEMENT COMPANY, OF SPOKANE, WASH., A CORPORATION.

Claim.—The combination, with a flue-sheet having an opening tapered or enlarged from the inside outward, of a flue-point having double the ordinary thickness of the ordinary flue and provided with a lathed-off or reduced portion at its outer end, the same terminating in a concave annular shoulder, and a soft metal gasket comprising a cylindrical body



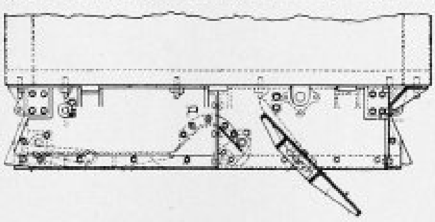
and a thickened bead or roll at one edge, which gasket is interposed between the reduced and shouldered portion of the flue-point and the adjacent portions of the flue-sheet, the outer ends of the flue-point and gasket being turned outward and beaded on the flue-sheet. One claim.

949,162. LOCOMOTIVE ASH-PIT. OTTO SPAETH, OF CHICAGO, ILL.

Claim 1.—The combination with the ash pit of a locomotive, of a draft tube extending from the rear thereof and having a forwardly projecting mouth located under the ash pit; and supplemental side draft tubes projecting forwardly from each side of the ash pit. Two claims.

949,017. LOCOMOTIVE ASH-PAN. HARRY A. HOKE, OF ALTOONA, PA.

Claim.—In a locomotive ash pan, the pan body having an open bottom, a vertically swinging dumping bottom plate arranged within said open bottom and provided with eccentrically disposed pivot journals journaled



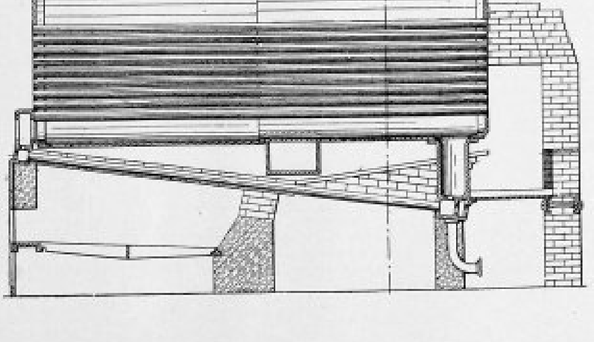
in the sides of the pan body, a holding lever rigidly fitted to one of said pivot journals, a releasable locking device for the free end of said lever, and a fixed stop arranged in the path of movement of said lever. One claim.

949,792. MEANS FOR RETAINING HEAT IN STEAM BOILERS. WILLIAM CHARLES CLARKE, OF SHELBURNE, ONT., CANADA.

Claim.—The combination with the boiler having the flues and smoke-box; of the closure body arranged and movable in the smoke box, and extensible rods interposed between the closure body and the outer end wall of the smoke box, and respectively comprisng a member having a lateral head in which is a longitudinally disposed threaded aperture, and a screw bearing and adjustable longitudinally through said aperture. One claim.

949,953. STEAM BOILER. THOMAS BARROW, OF DAVENPORT, IA.

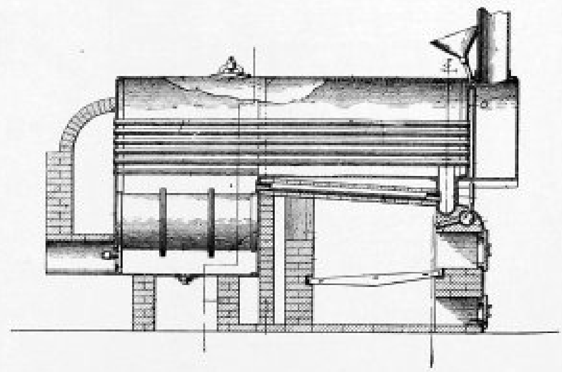
Claim 1.—The combination with a boiler, its setting, circulating tubes and hand-holes at the front and rear ends of said tubes, of separated chambers between the rear of the boiler and its setting, one of said



chambers being open to the fire while the other is closed to the fire, the hand-holes at the rear ends of said tubes opening into the latter chamber. Twelve claims.

949,956. STEAM BOILER. THOMAS F. DOWNEY, OF CHICAGO, ILL.

Claim 1.—The combination, with a Scotch boiler having a large flue in the lower part thereof and a plurality of small flues in the upper part thereof, of a furnace located in front of the lower part of the boiler and communicating with the large flue, a cylindrical shell extending from the upper part of the boiler to a position over said furnace, certain of the small flues being extended through said shell, a water leg at the front



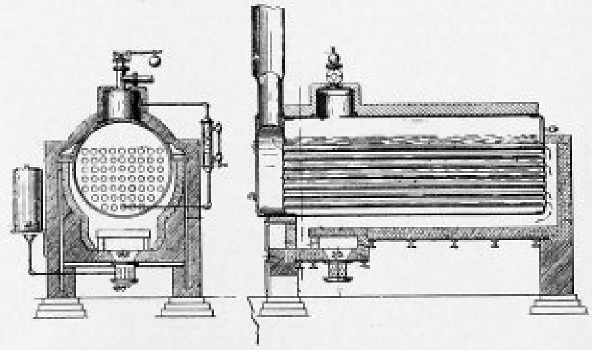
end of said shell, a flat series of water tubes connected at the rear ends with the front tube sheet of the Scotch boiler above said large flue, said water tubes being connected at their front ends with said water leg, said tubes supporting the top wall of the furnace, means establishing communication between the rear ends of said flues, and a smoke outlet for the forward ends of said small flues. Two claims.

950,005. LOCOMOTIVE. WILLIAM MOSLEY, OF ST. PAUL, MINNESOTA.

Claim 1.—In a locomotive, a boiler, a smoke chamber associated with said boiler having a smoke outlet, a valve in said outlet, an exhaust nozzle having its orifice in said chamber, a petticoat pipe above said nozzle, a reducer co-operating with the orifice of said nozzle, and means for simultaneously operating said valve and reducer; whereby after the valve is opened, the reducer can be moved to modify the exhaust issuing from said nozzle. Two claims.

950,293. STEAM GENERATOR. LUDWIG T. KUEHL, OF CHICAGO, ILL., ASSIGNOR TO GEORGE C. J. KUEHL, OF CHICAGO, ILL.

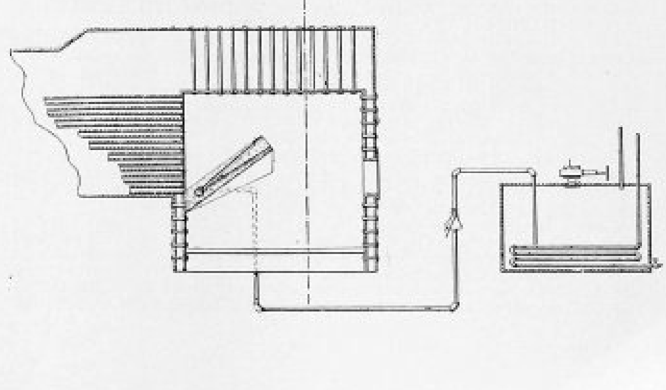
Claim 2.—The combination, with a steam generator proper, of means for generating the required heat, said means including a burner adapted to burn hydrocarbon fuel, and a brick setting for the boiler proper, there being in said brick setting a combustion chamber; a flaring passage



into said combustion chamber; a baffle plate above said flaring passage; front, and side passages leading from said combustion chamber around said baffle plate, a crescent-shaped passage underneath the boiler proper and a vertical passage on the back of said boiler. Three claims.

951,069. STEAM BOILER FURNACE. JAMES ARCHIBALD FORSYTH, OF ATLANTA, GA.

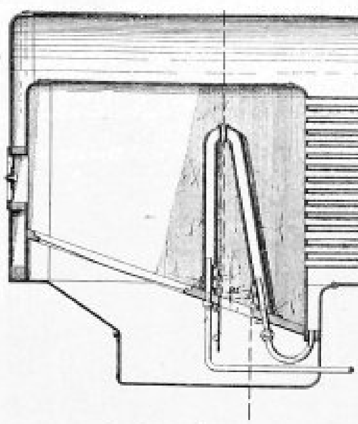
Claim 2.—The combination with a boiler fire-box having a grate, of an arch therein above the grate having a transverse opening, and passages



extending from said opening to the outer end of the arch, and opening therethrough, said passages being arranged in pairs, the members of which merge at the transverse opening, and extend divergingly therefrom, and a liquid fuel burner mounted in the arch, and discharging into the passages. Three claims.

950,666. HEATING DEVICE. CHARLES FORTH, OF BOSTON, MASS.

Claim 4.—In combination with a fire-box, a water heating casing situated therein and comprising two communicating water legs extending across the fire-box and dividing the same into a front chamber or fire-



box proper, a rear combustion chamber connecting with the front chamber at the top, and an intermediate air chamber communicating at its top with the front and rear chambers, and means for the admission of air to the air chamber. Five claims.

950,582. COMPOSITION FOR PREVENTING SCALE IN BOILERS. ADOLFO MARTINEZ URISTA, OF MEXICO, MEX.

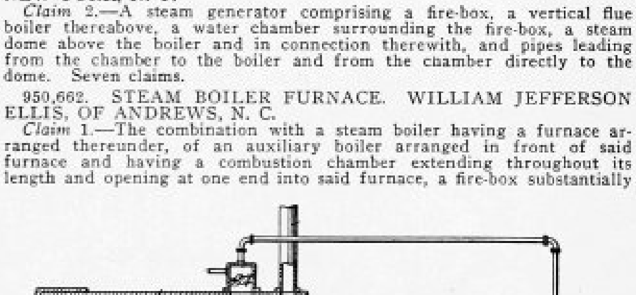
Claim 3.—A composition for removing the scale from the internal surface of boilers, consisting of a mixture of twenty parts of the alcohol commingled and united extracts by distillation of ramie, tobacco, nopal, neutleth, agave, and amaryllis, respectively, with eighty parts of water all in liquid measure. Three claims.

951,480. STEAM GENERATOR. JAMES M. LIVELY, OF NEW YORK, N. Y., ASSIGNOR TO WILLIAM DE L. WALBRIDGE, OF NEW YORK, N. Y.

Claim 2.—A steam generator comprising a fire-box, a vertical flue boiler thereabove, a water chamber surrounding the fire-box, a steam dome above the boiler and in connection therewith, and pipes leading from the chamber to the boiler and from the chamber directly to the dome. Seven claims.

950,662. STEAM BOILER FURNACE. WILLIAM JEFFERSON ELLIS, OF ANDREWS, N. C.

Claim 1.—The combination with a steam boiler having a furnace arranged thereunder, of an auxiliary boiler arranged in front of said furnace and having a combustion chamber extending throughout its length and opening at one end into said furnace, a fire-box substantially



surrounding said boiler and communicating with the combustion chamber throughout its length, circulating pipes connecting said auxiliary boiler with the other boiler, and a pipe connecting the steam space of said auxiliary boiler with the dome of the other boiler. Two claims.

949,079. RENEWABLE GRATE-BAR LEAF. THOMAS S. JOHNSON, OF SCRANTON, PA., ASSIGNOR TO SCRANTON STEAM PUMP COMPANY, OF SCRANTON, PA.

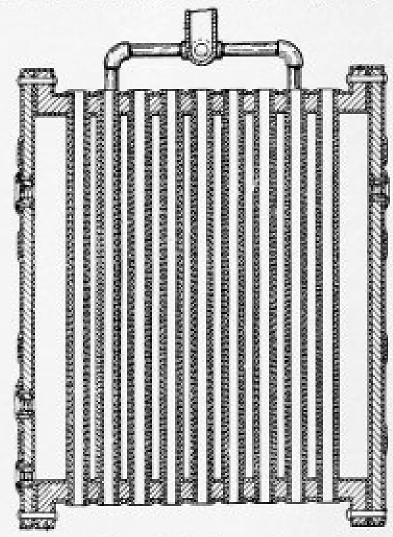
Claim 1.—In combination with cross bars having openings formed therein, grate bar leaves consisting of a shank I-shaped in cross section received in said openings of the cross bar, a head on each shank having an arc-shaped outer face, the under side of the head ends and said outer faces meeting to form cutting edges, and fingers projecting in spaced relation outwardly from each side of the heads, said fingers being arranged in staggered relation. Two claims.

951,474. ACTUATING MECHANISM FOR AUTOMATIC STOKERS. JOHN R. FORTUNE AND HAROLD S. WELLS, OF DETROIT, MICH., ASSIGNORS TO MURPHY IRON WORKS, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 2.—In an automatic stoker, the combination with feeding mechanism and a rock shaft for actuating the same, of a reciprocable actuating bar, and means for transmitting motion from said bar to said shaft comprising a rack on the bar, a gear segment engaging the rack and having a laterally extending arm, a lever mounted upon the end of the shaft to turn thereon and provided with a longitudinal slot, a connecting rod pivotally attached at one end to the arm of the segment and provided with an eye at its opposite end, a bolt engaging said eye and the slot in the lever, a pawl pivotally attached to the lever, and means on the shaft engaged by the pawl to cause the shaft to be turned by the turning of the lever. Three claims.

948,373. TUBULAR STEAM BOILER. STERLING ELLIOTT, OF NEWTON, MASS.

Claim 2.—In a tubular steam boiler, a set of tubes and a pair of tube plates to which said tubes are connected at their opposite ends, and a continuous non-corrosive metallic covering having a high melting point



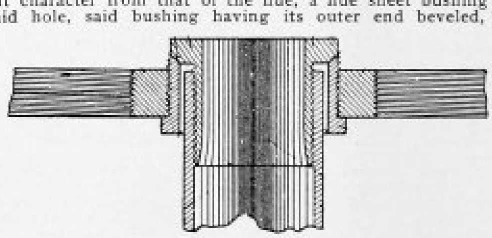
united to both the exterior and interior surfaces of the tubes and to both the exterior and interior surfaces of both tube plates, and forming integral fillets around the tubes at the junctions thereof with the tube plate. Three claims.

948,968. MEANS FOR PREVENTING THE CORROSION OF THE INTERNAL PARTS OF BOILERS DUE TO ELECTROCHEMICAL ACTION. PEREGRINE ELLIOTT GLOUCESTER CUMBERLAND, OF ST. KILDA, VICTORIA, AUSTRALIA.

Claim.—The combination with a boiler having a plurality of flue tubes, of a plurality of metallic electrodes disposed within the boiler between the tubes and engaging the water in the boiler, means for removably and replaceably holding the electrodes within the boiler and including devices for insulating the said electrodes from the boiler, conducting means insulated from the boiler and electrically connected to the electrodes, and a source of electric current connected to the said conducting means and the shell of the boiler, the electrodes constituting anodes and the boiler shell forming a cathode, the metal structure comprising the boiler being brought into parallel and the corrosion or decomposition effected upon the metal electrodes. One claim.

953,062. FASTENING FLUES IN STEAM-BOILERS. FREDERICK SCHMITT, OF SALT LAKE CITY, UTAH.

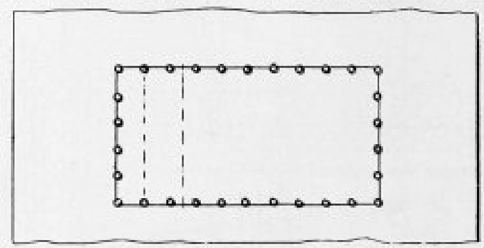
Claim.—In combination, a boiler flue having an internal thread of a certain character, a flue sheet having a hole with a thread of a different character from that of the flue, a flue sheet bushing screwed into said hole, said bushing having its outer end beveled, a space



being formed between the flue and the bushing, and a safe-end screwed into said threaded end of the flue and having a flange spaced from the end of the flue and abutting against the said beveled bushing end, the latter space communicating with the aforesaid space. One claim.

953,562. BOILER-PATCH. FREDERICK STRATTNER, OF SAILSBURY, MARYLAND

Claim.—The combination with a boiler sheet having an opening therein provided with beveled edges, of a plate shaped to fit said opening



with its edges beveled to fit the beveled edges of the opening, the edges of said opening and said patch having registering recesses formed therein and screw plugs operable in said recesses to secure said patch in position. One claim.

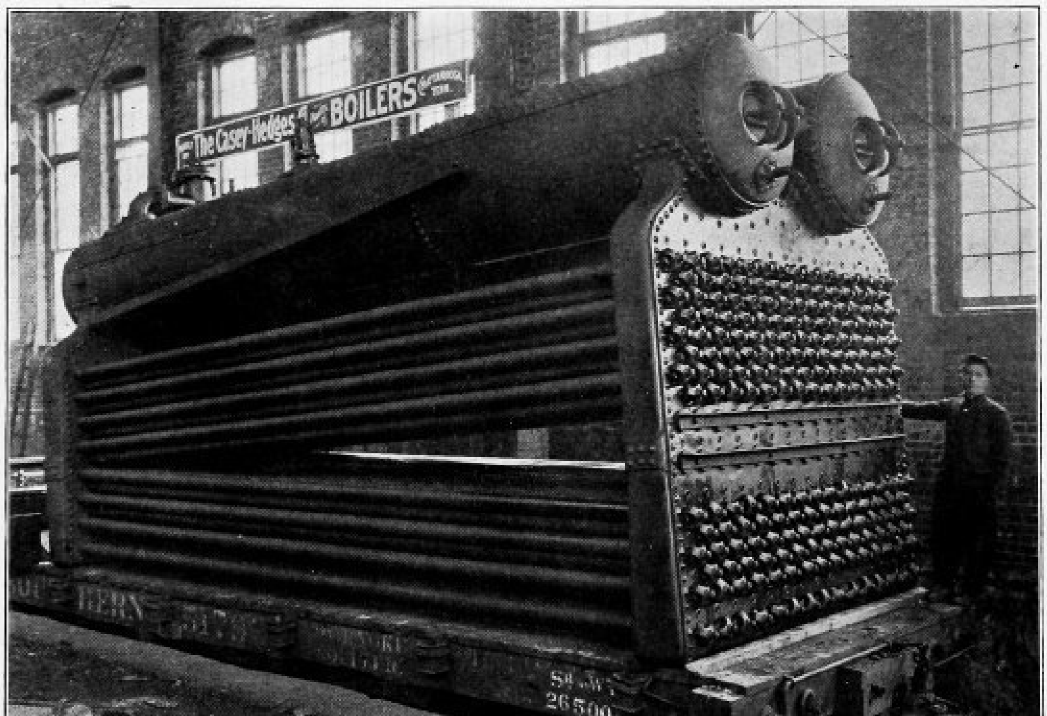
THE BOILER MAKER

JULY, 1910

THE CASEY-HEDGES WATERTUBE BOILER.

BY JAMES J. FLETCHER.

The illustration shows a 350-horsepower watertube boiler of the Casey-Hedges type. This boiler is made with one or two drums as the purchaser requires. The water legs are thoroughly braced with hollow stay-bolts of large area, and are so constructed as to form the strongest part of the boiler. The water legs are ample in size to contain a large volume of water, and to permit free circulation; the latter is a very important feature in the steaming qualities as well as in the life of any type of boiler, and particularly in watertube boilers. As can be seen in the photograph, the rear leg is increased in width from the center down to the bottom, allowing a larger area at the bottom for any accumulation of mud which may occur when impure feed water is used. This is a feature of construction which is typical with this boiler, and is claimed to possess great advantages.



350-HORSEPOWER CASEY-HEDGES WATERTUBE BOILER

The boiler is so baffled with firebrick that the flow of gases is parallel with the tubes. The lower bank of tubes is completely surrounded with fire-tiled casing, with the exception of a portion of the rear end, forming a Dutch oven furnace, thus insuring complete combustion and a practically smokeless boiler.

Economy in fuel consumption is one of the most important features claimed for this boiler, and the claim seems to be borne out by the experience which users have had with it. The furnace arrangement not only insures a smokeless chimney but results in a considerable saving in fuel.

The demand for this type of boiler is so great that the manufacturers are working their large boiler shop to its full capacity —working both day and night. Besides this type of watertube boiler the Casey-Hedges Company manufacture a large number of boiler tanks and stacks of all kinds. The factory is located at Chattanooga, Tenn.

THE WIDE FIRE-BOX.*

BY C. BOWERSOX.†

The question of fire-boxes is one that volumes could be written on, and the subject of WIDE FIRE-BOXES that will be up for discussion at our convention, is a question that concerns a majority of the railroads.

The railroad I am connected with, the Toledo, St. Louis & Western, have thirty engines with the wide fire-boves, and it is not an unusual thing for the boiler foreman to ask you to hold an engine for a patch or a few staybolts on this class engine, just when you want the power worst. While we have eliminated our staybolt trouble to a certain extent by applying the flexible staybolt, there has been nothing invented as yet to stop the cracking of the fire-box sheets.

As a comparison between the wide fire-boxes and narrow ones, we have ten engines with the narrow fire-box, carrying 200 lbs. of steam, the same pressure is carried by the engines with the wide fire-boxes. These engines have been in service for seven years without a patch in the fire-box, while the thirty engines we have equipped with the wide fire-boxes, each have from one to four patches. The majority of our boiler failures are on engines equipped witht the wide fire-box, as this class of a fire-box cannot be cooled down without starting the flues to leaking, on account of the contraction and expansion. Also the cost of maintenance of the wide fire-box is more than double the cost of maintenance of the narrow fire-box. During the previous year we renewed 492 staybolts in ten of our large engines equipped with the narrow fire-box, while we renewed 1,925 staybolts in ten of our large engines equipped with the wide fire-box in the same length of time, a total of nearly four times as great. A narrow fire-box engine coming off the cinder pit, after being put in the round house, does not require near as much attention to the fire-box as one of the wide fire-box engines, which naturally means a greater cost of maintenance. My experience has shown me that there is but very little difference in the fuel and water consumption between the two classes of fire-boxes.

No doubt every general foreman who has wide fire-boxes to contend with, will agree with me regarding the repairs and maintainance of fire-boxes of this class. As I could go on writing enough to fill a book, I would prefer to have an opinion of the general foreman at the convention regarding this topic.

ABSTRACT OF PAPER READ BY B. H. O. OLSON.‡

In writing a paper on this subject there are many things to be considered, such as saving of fuel, cost of repairs, the conditions under which the engines are to be worked, and size of engine.

When comparing the two types of fire-boxes it is of the utmost importance that the locomotives shall be used under the same conditions, and be the same size; but as a general rule the engines with the wide fire-box are much heavier and are expected to handle a greater tonnage.

Long before locomotives had reached their present enormous size and power, it was found that the old style of narrow fire-box would not give sufficient grate area for what was supposed to be the economical combustion of fuel. The idea was formerly held that the higher rates of evaporation were obtained with slower rates of combustion and with larger ratios of heating surface compared to grate area. It was not considered economical to burn coal at a higher rate of combustion than 75 pounds per hour per square foot of grate surface. That this idea is no longer universal is shown from the fact that narrow fire-boxes burning 180 pounds of coal per square foot of grate area are considered economical by some. This is made possible on account of being able to maintain a deep fire in the deep, narrow fire-boxes so that little chance for an excess of air to get through the bed of fuel and decrease the efficiency of combustion. But there is no doubt in my mind that a wide fire-box gives better results in fuel economy that the narrow on account of the greater grate area compared with the heating surface than can be had with the narrow, providing the wide fire-box is deep enough so that a good body of fire can be maintained at all times, a wide fire-box of the same depth in front as the toboggan fire-box, or not less than 36 in. under the flues, is not an impossibility, and would probably give better results from a firing standpoint and also cost less to keep in repair, but if the wide fire-box is too shallow it may not be economical in fuel on account of holes being torn in the fire and too much cold air admitted, reducing the temperature of the gases and interfering with proper combustion, and in this case, there is no question but that the cost of repairs is greater, caused by the thin fire allowing the cold air to come in contact with the flues and side sheets, causing leaks and cracks due to the variation in expansion and contraction.

As a general rule engines with wide fire-boxes are much heavier and handle a larger tonnage, which apparently increase the cost of repairs. This should be considered in comparing the wide with the narrow fire-boxes, and therefore the repairs and also the fuel should be figured on the tonnage basis.

One the Duluth & Iron Range road we have engines with the narrow and engines with the wide fire-box, and the engines with the wide fire-box have required more repairs than those with the narrow, although they have shown better fuel economy. This saving of fuel will more than pay for the extra expense of repairs, especially if the cost is figured on the ton-mile basis.

In conclusion I may say that if the wide fire-box is constructed and proportioned right it is superior to the narrow fire-box.

* Paper read before the International Railway General Foremen's Association, Cincinnati, May, 1910.

† General foreman, T., St. L. & W. R. R.

‡ Foreman machine shop, D. & I. R. R. Co., Two Harbors, Minn.

Economy of the Brick Arch.

At the recent Master Mechanics' Convention, Mr. D. R. McBain, superintendent of motive power, Lake Shore & Michigan Southern, made the following statement regarding the use of the brick arch:

"I have stood up on the floor of this convention in past years and said that it was impossible to maintain a brick arch in a modern locomotive. I believed it at that time, but years of experience and conscientious work on the part of motive power organization have convinced me that I have been wrong, and, speaking for the New York Central Lines, where we have good water and bad water, and all kinds of conditions to contend with, and some of the heaviest power in the United States, I want to say that the use of the brick arch is not only possible but very necessary in order to get the proper economy and efficiency out of the locomotive. I believe sincerely, and I think there are men in the meeting now who can produce figures to show that the proper installation and maintenance of the brick arch in the modern boiler to-day will save at least 10 percent, and that ought to be worth going after."

The Steel Corporation has increased the wages of its 200,000 employees an average of 6 percent, the added expenditure for this purpose being about $9,000,000 a year. It has also declared against Sunday work and in favor of giving employees in its manufacturing plants at least twenty-four hours' continuous rest each week.

FINISHING STAYBOLTS AND STRAIGHT AND TAPER BOLTS FOR LOCOMOTIVES.*

BY C. K. LASSITER †

The locomotive boiler of average size contains about 1,500 staybolts, the number varying from 1,200 in the smaller sizes to 2,000 or more, in the heavier types. They vary in length from 4½ inches to 10½ inches for the water-space bolts, which constitute about 75 percent of the total number, to about 28 inches for the radial and crown bolts.

Probably no part of the boiler is subject to more destructive conditions than these little staybolts. The most serious strains are those due to expansion and contraction of the inner sheet. This is especially true of the side or water-space stays, which are comparatively short and have very little flexibility.

The material used is a high grade of refined iron, close-grained and tough. The pitch being very important on account of entering the second sheet, these stays were formerly cut to length from the bar, drilled for centers, and threaded on engine lathes. The center drilling was not always concentric and considerable time was required to center the rough bolt so that a good thread could be obtained. This method proving too expensive, bolt cutters were used for the work, but the results were not entirely satisfactory. It was difficult to cut the threads full and smooth with one passage of the chasers and the second passage was taken at the sacrifice of pitch, as well as of time, because there was not enough material to remove to carry the chasers along properly. The introduction of the lead screw in bolt cutters brought about a very considerable improvement in pitch, but still there was trouble in getting the thread smooth for the reason that the chasers were not always as accurate as the lead screw, under which conditions the thread would be rough or torn.

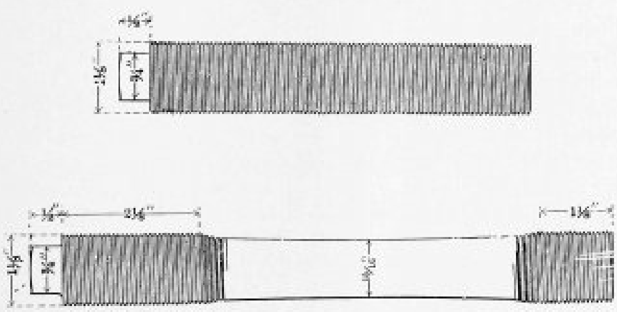


FIG. 1.—PLAIN AND CONCAVE SQUARE END WATER SPACE STAY.

About thirty years ago the idea was conceived of concaving the bolts or reducing them in the center below the root of the thread, the object being to provide flexibility to compensate for the expansion between the inner and the outer sheets. Laboratory tests showed that a bolt reduced in the center would withstand about twice as many vibrations before breaking as one on which the threads were left straight for the full length. For many years it was the accepted practice to reduce a bolt in diameter on engine lathes after it was threaded in the bolt cutter and drilled for centers.

In 1900, Alonzo Epright, an engineer in the employ of the Pennsylvania Railroad, designed machines which were fully automatic in that they made from the bar, threaded and concaved, all diameters of side stays up to ten or eleven inches in length. The author has no knowledge of the production of these machines and, therefore, can make no comparison of costs.

The vertical type of machine for threading these bolts was used to some extent and it seemed that if the proper chaser could be made the best results would be obtained from this type of machine because the weight of the head would assist the chaser to give an accurate pitch. In the horizontal or bolt cutter type the chaser must carry along the vise and carriage to the detriment of accuracy in the lead.

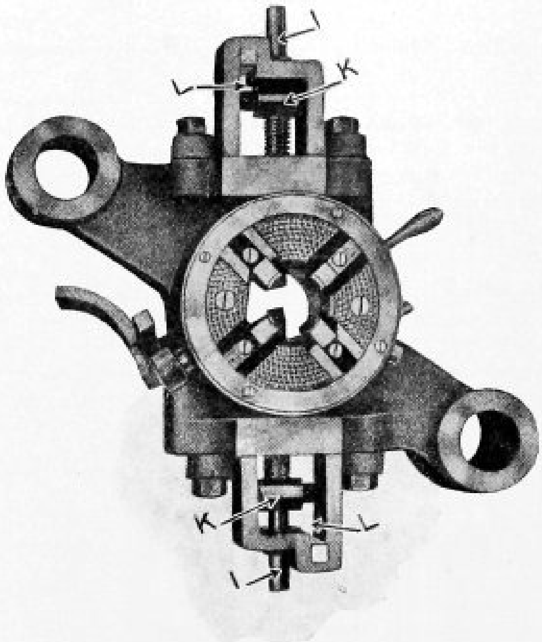


FIG. 2.—TURNING OR REDUCING TOOL.

Also, the flow of oil would assist in washing away the chips, which were troublesome in the horizontal machine. Furthermore, the vertical type of machine is more convenient to operate, one man attending six or eight spindles with ease.

After a great deal of experimenting a die head was developed in which, with chasers properly ground, the limit of accuracy of 0.01 inch in 8 inches can be maintained without the use of the lead screw, which is more nearly a perfect pitch than many staybolts taps in daily use. Where a proper lubricant is used a very fine, smooth thread can be obtained at a uniform cutting speed of 20 feet per minute.

The turning or reducing tools are shown in Fig. 2, the cutting points being visible at the center, back of the chasers. To these tools are attacked the crossheads KK, which are actuated by profilers or formers passing through the spaces LL, over which the head is drawn by the chaser, the staybolt acting as a lead screw.

The stay-bolt threading machine is shown in Fig. 3. The several die heads are attached by small rods to straps passing over the pulleys on a shaft at the top of the machine. The operator grasps one of the strap handles with his right hand and, by the aid of the rotating pulley over which the strap passes, raises the die head until it comes in contact with the bracket which closes the die. With his left hand he places the squared end of a staybolt in a holder underneath the die and allows the head to drop until the chasers begin to cut, when he moves to the next die head and repeats the operation. By the time he has placed all the heads in operation, the first bolt is finished, the die having dropped automatically when the threading was completed.

In Fig. 3 the die head at the right is shown raised sufficiently to insert the staybolt in place; the next at the left

* Paper read before the American Society of Mechanical Engineers, June, 1910.

† Mechanical Superintendent, American Locomotive Company, Richmond, Va.

is just beginning to thread the bolt and the two other die heads are in still lower positions.

A comparison of costs by the two methods, taking a 7½-inch side stay as an average length, would be about as follows:

FORMER PRACTICE.

Threading-in bolt cutter, usually taking two cuts at 20 cents	$0.40
Drilling for centers	0.22
Concaving or reducing on engine lathe	0.75
Cost per hundred	$1.37

PRESENT PRACTICE.

Present cost, threaded the entire length or threaded and concaved for all sizes and lengths, per hunderd	$0.13

Using the average number of stays, a saving of labor cost of $18.60 per boiler is obtained with a minimum of rejected stays.

METHODS OF DRILLING STAYBOLTS.

The telltale holes which are drilled in the staybolts have been the cause of considerable expense and annoyance. Some railroads drill them after the stays are placed in the boiler, with pneumatic hand drills. Under these conditions there is danger that the hole may not be central. It often happens that the drill runs through into the water space or is broken

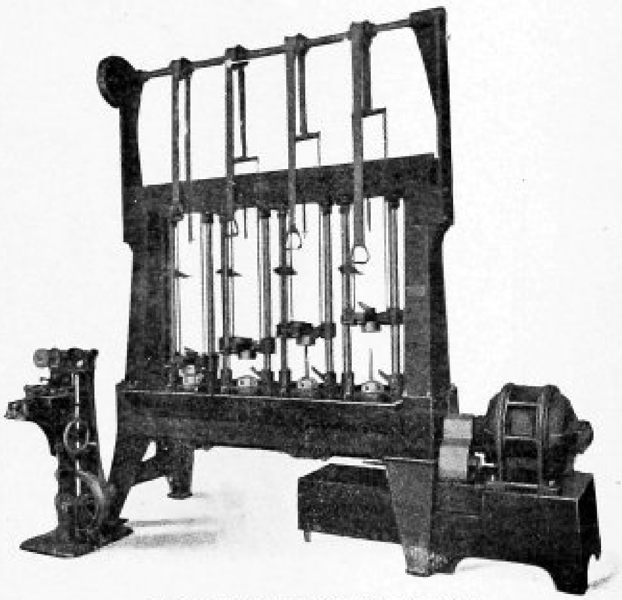


FIG. 3.—STAYBOLT THREADING MACHINE.

off in the hole. In either case it is necessary to remove the bolts and put in others. Sometimes the holes are drilled on a vertical drilling machine before being placed in the boiler. Even then the breakage of drills is very large, averaging about sixteen to the boiler, and each broken drill means a staybolt thrown away.

An automatic machine has been devised for drilling these holes before the stay is placed in the boiler. They are fed from a hopper and automatically centered in position for the drill. When the hole is bored about one-third of the depth, the drill is withdrawn and the bolt is carried forward in the turret mechanism which holds it to a second and a third drill, completing the hole. Each drill is 0.01 inch smaller than the preceding one, providing for a minimum of friction and a maximum of clearance for chips. The holes are of uniform depth and in the center of the bolt. The average breakage is about three or four drills to the boiler.

COMPARISON OF COSTS.

Drilling in the boiler, per hundred (to which should be added the cost of replacements	$0.90
Drilling under drill press, per hundred (to which should be added cost of drills and waste of material and labor)	0.45
Drilling in the automatic machine, per hundred (with the minimum number of broken drills and bolts destroyed)	0.12

METHODS OF FINISHING STRAIGHT AND TAPERED BOLTS.

The usual method of finishing straight and tapered bolts for locomotives was to drill for centers, place in engine lathes, face under the head, turn the body taper, turn the part to be threaded straight and to proper size, face down the thread end to length and shape, leaving the center intact, test and file to accuracy, and cut off center point, after which the bolt is ready to be threaded in the bolt cutter and to have the hexagon head changed to any special shape desired.

About 1889, S. M. Vauclain, Mem. Am. Soc. M. E., designed and used a turning head in connection with a vertical machine for bolts up to 12 inches long. Under rights obtained from him the Pennsylvania Railroad placed an equipment of this kind in its Altoona shops and that is the only railroad known to the author using other than engine lathe methods in finishing bolts.

As a great many straight and tapered bolts used in locomotives are 12 inches to 20 inches in length and even longer, it became necessary to design for this work a turning head which would handle taper bolts up to 18 or 20 inches in length and up to 1¾ inches diameter of thread, and straight bolts in any length up to 27 inches and up to 2½ inches diameter. It may be quite possible to go beyond these dimensions should the specifications require. These requirements have been met by a special machine of the vertical, multiple-spindle drill type, with which is used a special cutter head shown in Fig. 4. This head is the real or essential means of producing these bolts, either straight or taper and cylindrically true to the axis, the machine being simply a proper means of driving and feeding the bolt during the turning operation.

The cutter head consists of a retaining shell of cast iron, the bore of which must be round and straight; six segments, three of which are rigidly fastened to the shell, the other three having a limited amount of freedom and being fastened in place by a taper key with an adjusting screw located in the center of the radius with a bearing on the shell; and three blades, alternating with three guides, placed between the segments and backed up with taper keys and adjusting screws. The taper keys, in connection with a certain amount of taper on the blades and guides, have sufficient movement to provide for about one-eighth inch adjustment for re-grinding of the blades, or with the same amount on the guides, one-quarter inch in diameter of bolts. It will readily be seen that when an accurately ground plug gage of the size that it is desired to turn the bolt is placed centrally in the head, the blades and guides can be adjusted to their proper position. The three loose segments are then forced forward by the taper key, clamping the blades and guides rigidly in their proper working position.

The economical use of this method of turning bolts, particularly in the railroad shops and locomotive works where taper bolts are largely used, necessitates a change of system. The usual practice, especially on repair work, has been to carry in stock only standard sizes of forgings, though in some cases the more common sizes were placed in stock finished. With the engine lathe located near the locomotive being repaired, the bolts were fitted to the hole after the least possible amount of reaming had been done that would clean up the hole.

The improved system contemplates the turning, facing under the head, and placing in stock of standard sizes in lengths of 6, 9, 12, 15 and 18 inches, and varying in diameter under the head by thirty-seconds of an inch. Stock may be kept in sixty-fourths of an inch if desired, but very few holes will be found which require less than thirty-seconds of an inch to clean up. In fact, the chief reason for carrying the intermediate size would be to save the hole when it cannot be cleaned up within the next thirty-second. Standard reamers are used, with collars or marks to indicate when they have been driven to the required depth. All bolts have standard hexagon heads conforming to the thread diamter.

Bolts are specified with relation to the length and the diameter under the head, and the stock size next longest is used. Under these conditions not more than 3 inches must be cut off to bring the bolt to the proper length. The stock bolts are then taken to the bolt-altering machine, which is a quick-acting hand machine equipped with collet chucks and

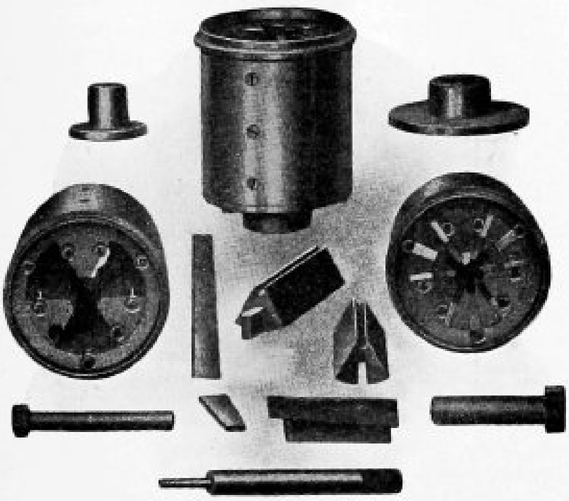


FIG. 4.—CUTTER HEAD AND ATTACHMENTS.

split bushings for the various diameters of the bolts. The end may be cut off to the proper length and turned for cotter pins, and the head changed to counter sink, box head, button head, or whatever may be required. After threading on the bolt cutter, the bolt is ready to drive in place without further fitting.

A comparison of costs by the two methods, taking a 1⅛-inch by 9-inch bolt as an average would be about as follows:

ENGINE LATHE PRACTICE.

		Cost per hundred
Drilling for centers		$0.22
Turning in lathe		2.50
Altering in lathe	$2.50 to	3.50
Threading in bolt cutter		0.22
Cutting off center points		0.10

PRESENT PRACTICE.

Pointing the blank		0.12
Turning by the method described		0.45
Cutting off and changing points and heads where necessary on the bolt-altering machine	$0.40 to	0.60
Threading in the bolt cutter		0.22

A device is now being perfected by which the threading can be done automatically at the same time the turning is done. This not only eliminates the bolt cutter charge of $0.22 per hundred, but assures a full, uniform thread absolutely in line with the body of the bolt and square with the facing under the head. When used in connection with a nut faced square with its thread the most satisfactory bolt is obtained.

A combined turning and threading device implies a modified form of the cutter head previously described, underneath which is attached a die head of special construction.

TABLE OF STOCK SIZES.

SHOWING EIGHT THREADED DIAMETERS OF BOLTS AND THIRTY-TWO DIAMETERS UNDER THE HEAD.

Thread diameter	3/4				7/8			
Diameters under head	25/32	13/16	27/32	7/8	29/32	15/16	31/32	1
Length under head	6 ..	6 ..	6 ..	6 ..	6 9	6 9	6 9	6 9
Thread diameter	1				1 1/8			
Diameters under head	1 1/32	1 1/16	1 3/32	1 1/8	1 5/32	1 3/16	1 7/32	1 1/4
Length under head	6 9	6 9 12	6 9 12	6 9 12	6 9 12 15 ..	6 9 12 15 ..	6 9 12 15 18	6 9 12 15 18
Thread diameter	1 1/4				1 3/8			
Diameters under head	1 9/32	1 5/16	1 11/32	1 3/8	1 13/32	1 7/16	1 15/32	1 1/2
Length under head	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18	6 9 12 15 18
Thread diameter	1 1/2				1 5/8			
Diameters under head	1 17/32	1 9/16	1 19/32	1 5/8	1 1/32	1 11/16	1 23/32	1 3/4
Length under head	12 15 18	12 15 18	12 15 18	12 15 18	.. 15 18	.. 15 18	.. 15 18	.. 15 18

This die head is carried on four or more vertical rods or guides which are attached to a ring to which the cutter head is fastened. Provision is made for squaring the die head with the cutter head at the time it begins cutting the thread, and at the same time automatically placing the die head in a position where it is free to move in a vertical plane up or down in exact proportion to the difference between the feed and the pitch of the thread to be cut. An automatic knockout is provided which opens the die head and passes to one side, allowing the threaded bolt to go through to any length within the feed of the machine. Under these conditions it will be seen that so long as the length of the thread to be cut is the same, the length of bolt to be turned is immaterial. The device is very simple in its construction and does not call for a skilled mechanic to adjust or operate it.

SUPERHEATERS FOR LOCOMOTIVE BOILERS.*

BY A. L. FALL.

In the last 25 years, steam pressures on locomotive boilers have been gradually increased from 140 to 225 pounds working pressure. The result has been that the cost of boiler repairs has been very much increased on account of the decreased life of fire box, stay bolts and flues. Superheating affords a convenient means of adding heat to steam without increasing its pressure; also the advantage to be obtained by enlarged cylinders. There is no question but that consid-

* From a paper read before the International Railway General Foremen's Association, 1910.

erable economy is obtained by the use of superheated steam, preferable of reduced pressure, say, of 160 pounds, to avoid excessive boiler repairs. This is especially desirable in bad water districts, and it is possible to effect considerable economy in this direction. The smoke box type of superheater develops a low superheat of 25 to 50 degress F.; the single loop fire tube superheater a moderate superheat of 100 to 125 F.; the double loop fire tube a high superheat of 175 to 250 degrees F.

Saturated steam at 160 pounds has a temperature of 370 degrees at 200 pounds 388 degrees and at 225, 397 degrees, or an increase in heat of about 27 degrees for practically the entire range of pressures in locomotive practice. The low degree of superheat as afforded by the smoke box superheaters adds 35 to 40 degrees, which is more than can be obtained by means of high pressures.

Moderate and high superheat, on the other hand, affords a convienent and pactical means of adding from 100 to 250 degress of heat. When superheated steam has received, say, 175 degress of additional heat after removal from contact with the water, it is found that 175 degrees of heat can be extracted at a constant pressure before it reaches the saturation point. Therefore, its expansion will partake of the properties of gas and the loss due to the condensation and re-evaporation of the cylinder walls will be largely avoided.

If the superheat is high enough to supply not only the heat absorbed by the cylinder walls, but also the heat equivalent of the work done during the expansion, then steam will be dry and saturated at release. The firebox temperatures in locomotives must be at least 1,800 to 2,200 degrees. The smoke box temperatures will range from about 550 to 700 degrees.

Tests made on superheaters show a saving of 12 to 20 percent in fuel and a saving in water of 15 to 25 percent, it being larger because more fuel is required for the production of one pound of superheat than for the same quantity of saturated steam.

In order to obtain 150 to 175 degrees of superheat and over, it is necessary to resort to the fire tube form of superheater, as it is not possible by any designs of smoke box superheaters to get sufficiently high temperatures in the smoke box without using a large 10 or 12-inch flue in the bottom of the boiler, as in Schmidt's earlier designs. The use of these large flues has been abandoned, even by Schmidt, on account of the extra cost of installation and maintenance, and practically all the designs recently equipped with the Schmidt system have used the fire tube style.

HOT-WATER WASHOUT FOR BOILERS.*

BY C. H. VOGES.

The National hot-water locomotive boiler washing and filling system was installed and placed in operation at the Bellefontaine roundhouse in December, 1909. It is equipped with two Dean duplex pumps 12x8½x12 inches; the capacity of the filling pump is 500 gallons per minute; the washout pump will wash three boilers at a time with a pressure of 90 pounds. The filling storage tank has a capacity of 12,000 gallons, and the washout tank a capacity of 85,000 gallons.

In the operation of the system, the steam and water are blown out of the locomotive through a blow-off line between the pits and into a filter in the washout tank. In this filter the steam and water strike a baffle plate, where the steam is separated from the water; it then rises and passes through the blow-out steam pipe into an open heater on the filling tank. The steam and water passing to the filter opens a flop valve, which is connected to the fresh water line valve. This heats the cold water, automatically admitted by the blow-off steam and water, and in a sufficient quantity to refill the boiler. The heated water follows from the open heater to the storage tank for filling purposes. A thermostat is placed in the storage filling tank and controls a live steam valve, which is opened when the temperature of the filling water is below the desired temperature. In connection with the filling tank there is a float valve for the purpose of controlling the admission of fresh water to the filling tank when the level of the water falls below a certain point. In this manner we always have a miniumum amount of water for filling purposes.

It takes 1 hour 56 minutes to wash and fill a boiler, including the cooling of the boiler and letting out of the water. You can wash a boiler quicker than this, but I doubt if you can do it right. The water in the washout tank is ordinarily about 185 degrees F., being regulated by a valve on the cold water line. This valve is actuated by a thermostat inserted in the tee in the suction line, the thermostat assuring a positive temperature of the washout water. The filling water is ordinarily about 190 to 200 degrees F.

This plant saves water, saves fuel, removes the mud and scale in the boiler before it gets baked, and save leaky flues.

* From a paper read before the International Railway General Foremen's Association, 1910.

PAPER BY C. L. DICKERT.

The time consumed for our washing system at Macon, Ga., using the plant installed by the National Boiler Washing Co., Chicago, is as follows:

Washing Broad Firebox Consolidation, 1,700 Class, 22x30 Inches.

	Minutes.
Coupling blow-off hose	3
Blowing off boiler, 50 pounds steam, 2 gages water	40
Removing 22 mud plugs	15
Washing boiler	20
Putting in mud plugs	7
Filling boiler, 1 gage water	14
Getting 50 pounds steam	30
Total, 2 hours and 9 minutes, or	129

Washing Narrow Firebox Consolidation, 1,030 Class, 21x32 Inches.

	Minutes.
Coupling hose	3
Blowing off boiler, 90 pounds steam, 1 gage water	42
Removing 18 mud plugs	16
Washing boiler	31
Putting in plugs	12
Filling boiler	7
Getting 50 pounds steam	34
Total, 2 hours and 25 minutes, or	145

This class of boiler is the most difficult we have to wash.

Small 1,500 Class Engines, 18x24 Inches.

	Minutes.
Coupling hose	4
Blowing off boiler	18
Removing plugs	11
Washing boiler	9
Putting in plugs	3
Filling boiler	5
Getting 50 pounds steam	23
Total 2 hours and 13 minutes, or	73

Temperature—Washing, 150 degrees; filling, 200 degrees.

System of Washing in All Cases.

1. Crown sheet.
2. Flues at front end near checks.
3. Belly of boiler and bottom flues from front end of boiler toward firebox.
4. Back head, above and below fire door.
5. Sides.
6. Throat and back flue sheets.
7. Arch pipes.

Washing water, 140 pounds pressure; filling water, 180 pounds pressure.

BOILER EXPLOSIONS AND THEIR CAUSES.*

BY G. W. BUCKWELL.

It is astonishing how, previously to twenty-six years ago, scientific and technical gentlemen, versed more or less in engineering matters, sought to account for explosions of boilers by means of causes which were, to say the least, beyond the ken of any ordinary individual. The idea seems to have been to attribute everything to such very high-class causes that only a high-class individual, such as a technical expert or professor, was able to deal with the matter, it being quite beyond the brain of the common or garden engineer why such a thing as a boiler explosion should take place. The result of this has had an effect lasting even to the present time, for it is not at all an uncommon thing, even now, for a great deal of supposed mystery to envelop an explosion, and extravagant theories are advanced to account for what is usually due to an extremely simple cause; that is, they are advanced by persons whose education has not included a series of boiler mishaps.

Away back in the seventies of last century, these scientific causes of boiler explosions were three in number, namely: Firstly, the spheroidal condition of water; secondly, water purged from air; and, thirdly, the hydrogen theory. They were all, of course, plausible, but extremely unlikely, and probably not one ever caused an explosion.

Firstly, the spheroidal condition of water. If a drop of water be thrown upon a very hot plate, as the top of a stove, it immediately assumes the spheroidal condition, whereas if the plate be only warm, the water will spread over it and evaporate as steam. In the spheroidal condition the globules of water do not reach boiling point, but between them and the hot plate are cushions of steam, which prevent them coming into contact with the hot plate. A lowering of the temperature of the plate, either by the source of heat being removed or by the globule rolling to a cooler spot, causes the water to lose its spheroidal form, and to spread out, when it immediately evaporates as steam, and an excessive pressure is developed. Applying this to the case of a boiler, if from lack of feed the water should assume the spheroidal state, and also on account of the same lack of feed the fire is damped, then the furnace will cool, the water leaves its spheroidal form, and spreads over the furnace, generating steam in too large quantities to pass the safety valve, and, of course, the inevitable explosion follows. A very pretty theory, but at the present day we should ascribe the cause to insufficient area of safety valve compared with the grate and heating surfaces.

Secondly, water purged from air. All water holds air; boiling sets it free. The air in the water forms the cushion in hydraulic plant, as it prevents the molecules of the water approaching one another too closely. If the air be removed, the molecules of water are able to get closer together, and are more firmly locked to one another; that is, their cohesion is increased. Indeed, it is said that their cohesion is so increased that the temperature may be raised as much as 50 degrees F. in excess of the usual temperature before boiling is produced. But when boiling once starts, the excess heat is at once used to convert the water into steam, and the explosion follows. In the old days it was nothing uncommon for locomotive boilers to explode on leaving the running shed. This theory was a favorite one to account for these explosions. It was explained that the water had been cleared of air by previous boiling, and then, on getting the fire ready again, the heat, instead of making steam, simply stored up an excess of heat in the water, and on the throttle valve being opened, the equilibrium was disturbed, boiling commenced, and the explosion followed. The chief causes of locomotive boiler explosions will be dealt with later, but it may be said that the above theory was not the correct one, and, of course, was only a possible explanation in the days when only common jet condensation of high-pressure engines were used, and when the feed water always contained air. At the present day, with surface condensation, we do our utmost to keep the air out of the boiler in the first instance, as it is the presence of air in the water that is the primary cause of corrosion.

Thirdly, the hydrogen theory. Pure water consists of hydrogen and oxygen. It was suggested that when water came into contact with red-hot boiler plates, it was decomposed into its constituent elements, and then immediately reunited to form steam, the combination being effected by an explosion, as students of elementary chemistry know from their lecture-room experiments. This theory was evolved to account for explosions due to shortness of water and the admission of feed water on the hot plates, and was as far-fetched as the theory of the spheroidal condition. That water is decomposed into its constituent elements is perfectly true in certain descriptions of heating apparatus, which will be referred to presently, but it is not the case in any ordinary boiler.

The first boiler explosion act became law in 1882, and it gave powers to the Board of Trade to investigate every explosion of a boiler, with the exception of domestic boilers and boilers in Her Majesty's navy. There were other exceptions, but these were removed by an amending act in 1890, and it may be said that the acts, as they now stand, order investigations to be held in all cases with the above exceptions, and these are qualified to the extent that a boiler for the navy must have actually been handed over to the Admiralty by the contractor, and the domestic heating boiler must be used purely for ordinary domestic purposes in a private house only. The result of the inquiries held under these acts has been that a perfectly simple cause has been found for every boiler explosion, and, what is more to the point, they are all strictly preventable. These causes, as now ascertained, range themselves under various heads, according to the class of boiler, as follows:

Marine boilers usually give way owing to internal corrosion, defective stays, or accumulation of salt or scale.

Locomotive boilers usually give way owing to grooving, defective stays and cracks developing, due to movement of the boiler.

Lancashire boilers usually give way owing to overheating of flues, external corrosion and improper setting.

Cornish boilers usually give way from the same causes as Lancashire boilers, with the additional cause of weakness of the large single flue.

Egg-ended boilers usually give way from straining and external wastage, due to overwork. These boilers have a large area of fire-grate, and are consequently forced to a very large extent.

Portable boilers usually give way from over-pressure and corrosion. This also applies to contractors' locomotives, as both types of boiler are looked after—or not looked after—by a class of driver akin to the average chauffeur—chock full of bravado and with no sense of danger.

* From a paper read before the Barrow and Disfrict Association of Engineers.

Watertube boilers usually give way from accumulation of scale in the two or three rows of tubes adjacent to the fire.

Vertical boilers give way from all the above causes except improper setting. They are also often attended to by a class of men who would require considerable education to become even elementary engineers.

Steam pipes usually give way from want of proper means for taking up the stresses they are subjected to, either by expansion or by movement of the machinery they are connected to.

Stop-valve chests in nearly all cases give way owing to water hammer, and where they do not suffer, it is the steam pipe in connection that does so.

Heating apparatus of all types gives away from over-pressure or over-heating.

Of course, it is understood that in the above list the causes enumerated probably account for 95 percent of the explosions in each case. The remaining 5 percent are due to special causes, which always need to be specially divined, but when one hears of an explosion, one is usually pretty safe in the first instance, before seeing the results of the explosion, in ascribing it to one of the causes stated.

With regard to the danger and damage due to shortness of water, there is a widespread opinion that it causes serious results, such as scalding to persons and destruction to the boiler. A little consideration will show that this cannot possibly be so. If a boiler gives way owing to shortness of water, it is an axiom that there is very little water left in the boiler from which steam can be formed at atmospheric pressure when the explosion takes place, and the contents of the boiler are then only subjected to a pressure much less than that at which the boiler is usually worked. The first cause of the explosion in such a case is the over-heating and consequent reduction in strength of the plate on which the flame acts. Then the pressure inside the boiler is greater than the plate can withstand in its weakened condition, and it bulges and then gives way. According to the pressure at which a boiler works, the water inside has to be at a corresponding temperature; the higher the pressure of steam, so the higher the temperature of the steam; and the temperature of the water must be higher still, as it must have sufficient pressure within each bubble to force its way from the heating surface up through the water above it to the surface of the water, and then to still have sufficient force left to burst, and become steam, against the pressure of the steam already in the steam space. Now, when the flame-plate gives way by overheating, due to shortness of water, the water then remaining in the boiler possesses this excess of temperature over 212 degrees, at which temperature it boils in the open air, which causes it to form steam suddenly, but, owing to the small quantity of water, the formation of steam is soon finished, and very little damage is done to the boiler, though, if the space be confined, it may result in the scalding of the persons who are close by.

The idea that shortness of water causes great destruction has, at least, antiquity to recommend it. In June, 1837, a boiler exploded on the steamship *Union* at Hull, causing the death of twenty-four persons, and such injury to the vessel that she sank. The coroner who held the inquest afterwards stated that the opinions of scientific men with regard to the explosion were very varied, some believing that highly-heated steam, rapidly generated, was sufficient to occasion all the terific violence in the case of the explosion under consideration, whilst others thought that it was occasioned by the ignition of hydrogen gas produced by the decomposition of the water on coming in contact with the red-hot furnaces. The coroner's own opinion, based on the evidence given, was that the engineer of the vessel, being deceived either by the water-gage taps being out of order, or else by his want of attention to the quantity of water in the boiler, the tops of the furnaces were bare of water and became heated to a red heat; while the boiler was in this state the vessel oscillated, owing to persons on board moving from side to side, or from goods being carried across her, and that the water between the furnaces was by such oscillation thrown on the top of the furnaces, whereby a great volume of highly elastic steam was instantly generated, and which, having no sufficient outlet for escape, no ordinary safety valves being able to liberate the amount of steam generated, caused the fearful catastrophe.

In another case a destructive explosion occurred at one of the dockyards, the boiler being torn to pieces, the adjoining one dislodged, and considerable damage done otherwise. The cause was a simple one; the plates of the shell were wasted by external corrosion till they were as thin as an old sixpence. Yet the evidence given at the inquest by three eminent scientific witnesses caused the verdict to be that the deaths of the deceased were caused by the accidental explosion of a boiler, and that such explosion resulted from an insufficient supply of water.

To throw light on this vexed question, the Manchester Steam Users' Association, as long since as 1867, carried out experiments with the object of ascertaining the result of injecting cold water into ordinary private domestic circulating boilers, and found that no explosion followed. This was in conseqence of the explosions of ordinary circulating boilers at hotels and mansions in the early sixties, which had been ascribed to the favorite cause, but in all but three of the cases the real cause was the choking of the outlets by ice, and in those three cases, which occurred when there had been no frost, it was due to stop taps being fitted, and to them being shut up at the time.

In the year 1889 the Manchester Steam Users' Association carried out a further series of experiments on the subject, this time with a full-sized Lancashire boiler, at Preston. The boiler selected was of the ordinary type, with plain furnaces, lap jointed and single riveted, the furnaces not being strengthened in any way. It was 27 feet 9 inches long and 7 feet diameter, and the furnaces were 3 feet diameter and 7/16 inch thick. The material was iron throughout, and there were 18 square feet of grate surface in each furnace. The following fittings were attached to the boiler: Two feed valves, with internal perforated dispersion pipes, so arranged that they discharged the feed water on the tops of the furnaces. Two glass water gages, each 18 inches long, one having its bottom at 2 inches below the level of the furnace crowns, and the other having its top at 2 inches above the crowns. The range of water level to be seen was, therefore, from 16 inches above the furnace crowns to 16 inches below them; one blow-out tap, one dial pressure gage, ranging to 150 pounds, two safety valves—one of the external pendulous deadweight type, and the other of the ordinary box-lever type. Three gage rods tapped into the crown of each furnace, and carried up through stuffing-boxes in the top of the shell, for ascertaining the distortion of the furnaces. They were placed, respectively, about 4 feet, 7 feet and 12 feet from the front end. Barricades were also erected to shield the observers in case of serious damage being done to the boiler. There were, in addition, other fittings necessary for the carrying out of the experiments, together with a special tank for measuring the quantity of water used, and a special pump capable of supplying four times the quantity of water usually evaporated by a Lancashire boiler of that type. This was done in order that the conditions of the experiment might be similar to the conditions in practice, when the feed supply of a range of three or four boilers would be turned on to the one boiler only when it got short of water.

A series of thirteen experiments was carried out in all, and the main results were as follows: When the water level was lowered by opening the blow-out tap, thus allowing the furnace crowns to be laid bare rapidly, and consequently large surfaces to be exposed to the overheating effects of good fires, the sudden injection of the water caused a sudden rise in the steam pressure, followed by an almost immediate fall to less than the original pressure. The furnaces were not rent by sudden contraction on the introduction of the feed, nor was an ungovernable rise of pressure suddenly generated, and the shell was not affected. The only result was the flattening of the furnace crowns and the springing of the ring seams of rivets over the fire.

Unfortunately, in one of the experiments the feed water was not injected soon enough, and collapse through overheating occurred at the moment the order was given to turn on the feed. One furnace gave way at the seam immediately over the fire, forming an opening about 3 square feet in area, through which the steam and water rushed out with great violence, but neither the furnace mouthpiece nor fire-door were blown out of place, nor was the boiler stirred from its seat or otherwise damaged. This experiment showed, however, that a furnace crown when overheated may collapse with little warning, and if a large surface be overheated, the collapse is sudden, and hence to attempt to draw the fires when shortness of water has occurred, relying on the gradual coming down of the crowns, is a very riskly thing to do. The danger of this was proved at Clay Cross in January, 1869, and at Gorton in September, 1885. In each case the fireman was drawing his fires when he found the boiler short of water, and while engaged at this the furnace crown collapsed and gave way, and two men were scalded to death. Also at Hull, in July, 1874, a blow-out tap had been opened and stuck fast. The fireman was attempting to shut it when the collapse occurred, and he and another man were fatally injured.

As it is by evaporation that furnace crowns usually get bare in actual work rather than by the opening of the blow-out tap, the majority of the experiments were carried out with the intention of finding out what the results would be under such circumstances. The method of operating was to open the blow-out tap till the water sank to the level of the furnace crowns, then shut the tap, and keep the fires burning briskly for a specified number of minutes, then at the expiration of that time to turn the feed on full bore. In each case there was no rise in steam pressure. On the contrary, it began to fall, although there was conclusive evidence, from the condition of fusible discs, that had been laid on the tops of the furnaces, that the crowns must in some cases have been red-hot. The damage to the furnaces merely consisted in free leakage from the ring seams over the fire.

These experiments clearly proved that putting cold water on red-hot furnace crowns was not the cause of explosions, but rather that it prevented them.

A frequent cause of steam pipe and stop-valve chest explosions is water hammer. Unfortunately its causes are not so well understood as they should be. It may be said that, generally, for water hammer to occur there must in the first instance be an opening formed through which the water starts to escape, and in the second instance there must be a large area of water surface on which the steam can act. Also, the larger the area of the opening through which the water starts to escape, the more violent the shock. The action of water hammer is best explained by a diagram.

With regard to the formula used in connection with boilers, the occurrence of explosions has tended to largely modify the old-time standards. Take, for instance, Fairbairn's formula for the collapsing pressure of furnaces:

$$P = \frac{806300 \times T^2}{L \times D}$$

In 1882 a list of forty-six Cornish and Lancashire boilers was drawn up by the present Engineer-Surveyor-in-Chief to the Board of Trade, the internal tubes of which had collapsed through weakness, although possessing an apparent mean factor of safety of 2.15 by Fairbairn's formula. It was therefore evident that that formula required modification to the extent of a further division by 2.15, or

$$P = \frac{806300 \times T^2}{L \times D \times 2.15} = \frac{375023 \times T^2}{L \times D} = \text{say } \frac{375000 \times T^2}{L \times D}$$

Where D = external diameter of furnace tube in inches.
T = thickness of tube in inches.
L = length of tube in feet.
P = collapsing pressure in pounds per square inch.

The truth of the modified formula was proved with a boiler that exploded at Rothwell Haigh, Yorkshire, in October, 1883. The modified formula gave a collapsing pressure of 79½ pounds, and there was 80 pounds actually on the boiler when the flue did collapse.

When the temperature of heated water is known at the moment of release from a boiler by an explosion, the expansive energy in foot-pounds of each pound weight of the water is determined by the formula:

$$V = 8\sqrt{W}$$

$$W = 772\left[T - \left\{212 + 673 \text{ Hyp. Log.}\left(\frac{T + 461}{673}\right)\right\}\right]$$

Where T = temperature in degrees Fahrenheit immediately before release.
W = energy in foot-pounds per pound of water.
V = velocity in feet per second.

On March 7, 1884, a casualty occurred on board the steamship *Elizabeth and Ann,* a vessel belonging to Maryport. The owners were out on a pleasure trip at the time, and had only left Maryport half an hour before. The boiler, which had been made on the Tyne in 1875, was of the ordinary single-ended marine type, with two furnaces, and worked at a pressure of 40 pounds. The lower part of the combustion chamber, which was common to the two furnaces, gave away just beyond the landing at the back end of the port furnace, owing to corrosion on the fire-side, caused by a leak from the landing. Some thoughtful person had covered this corrosion with cement to hide it. The fireman had his feet scalded, and the vessel was towed into port by the harbor tug.

On Feb. 17, 1887, a vertical boiler exploded on board a dredger at Lancaster, while lying alongside St. George's Jetty, in the River Lune, resulting in the scalding of the engine man, and his death the same day in the Lancaster Infirmary. The boiler was of the usual vertical type, with two cross tubes, except that the crown of the fire-box was considerably more dished than is usual; it had been made at Leith seventeen years previously. The fire-box collapsed completely, an opening about 3 feet square being formed through which the contents of the boiler escaped. The boiler was projected 52 yards from the dredger before it fell, and then continued another 12 yards along the ground before it stopped in its flight. The safety valve was of the lever and weight type, and the spindle, which was of brass, worked through a hole in a cast iron cover, and this hole was found after the explosion to be lined with a hard scale consisting of coal dust and iron oxide. Evidently, therefore, the spindle had been fast in it, as, being brass, it expanded more than the cast iron cover, and the explosion was the result of over-pressure.

On July 2, 1888, an explosion occurred aboard the steamship *Weston* while on a passage from Whitehaven to Maryport. The boiler was thirteen years old, and was of the usual marine type, with two furnaces, with a common combustion chamber. The bottom of this chamber had become reduced by corrosion until at one part it was only a knife edge in thickness, which was too thin for a working pressure of 55 pounds, hence the explosion.

On Sept. 16, 1891, the steamship *Vulcan* nearly drifted ashore on the Cumberland coast while on a passage from Ellesmere port to Harrington. A rivet in one of the circular seams of the shell had been leaking, but as it was shut in by the bunker side, and awkward to get at, it was allowed to go on, until the plate was corroded to such an extent that a hole 1 inch in diameter was formed, and through this the boiler emptied itself, and the vessel drifted helplessly on a lee shore. Her position was considered so critical that the Millom customs officer wired to Barrow for the lifeboat, but she was picked up by a tugboat and taken into Millom.

On July 25 and 26, 1892, the *Ariadne*, of Barrow, met with two mishaps to her boiler. The boiler was only eight years old, having been originally built for the *Avelisino;* but that vessel not being ready for it, it was put into the *Ariadne*. The height of the space from the bottom of the vessel to the bottom of the boiler was very small, so that, with water in the bilges, inspections were awkward. Leakage occurred at the bottom of the boiler from the two center circular seams until the corrosion became so deep that holes were formed, through which the contents of the boiler escaped. The first mishap occurred while the vessel was proceeding down Walney Channel, and when this was put right, the second mishap occurred while she was anchored off Piel Island.

On Sept. 12, 1893, the joint of the bottom manhole door of the boiler on the *Solway Queen* blew out for a length of 2½ inches, causing the boiler to empty itself into the stokehold. She had loaded machinery in the Devonshire Dock, Barrow, for Her Majesty's ship *Flora*, and was about to proceed to Pembroke when the mishap occurred. A boiler inspection had taken place the day previous, and as steam was required for that day, the door joints had been made in a hurry, with the result that the lower manhole door had not been fitted centrally, and gave trouble all the time steam was being raised, till eventaully the joint blew out as stated.

While on the subject of giving way of the jointing material of manhole doors, I dare say it has been noticed that a very slight fiz from a door has gradually resulted in the wasting away of the boiler plate. This was the subject of an investigation a short time ago. A flat asbestos ring of the usual type, coated with blacklead, was used for making a bottom door joint, and later on this scarcely-noticeable fizzing referred to took place. When the door was next taken off, rather extensive corrosion was beginning to take place. The blacklead-coated asbestos ring was carefully cut in two, midway between the inner and outer edges. The two separate portions were then analyzed. The inner portion, which was farthest from the boiler water, was dry and free from arsenic. The outer portion, which was nearest the boiler water, was damp, and contained arsenic in the blacklead coating. The conclusion was, therefore, that the blacklead contained arsenic, which combined with the escaping water, and the corrosion of the plate was the consequence.

On Feb. 20, 1895, the boiler of the *Mary Ellen* gave out while she was alongside the quay at Lancaster. She was the paddle tug belonging to the River Lune Commissioners, and the boiler was fourteen years old. There had been leakage from the boiler flange of the main check-valve chest for about six months previously, but it had not been considered serious, and no special precaution had been taken to ascertain its effects. Eventually an area measuring 3 square inches became so thin through corrosion that it gave way under the ordinary boiler pressure, and the occupants of the engine room were driven on deck.

On Dec. 14, 1905, an explosion occurred on board the steamship *Enterprise*, the vessel at the time being in the River Lune, about half-way between Lancaster and Glasson Dock. The boiler was twenty-two years old, and had had fairly extensive repairs at various times. The cause of this explosion was the thinning of the plate by internal corrosion over an area measuring 4½ inches by 2 inches in the saddle plate at the back of the furnace on the port side. A special feature of the case was the fact that a stay at the bottom of the combustion chamber had leaked, and a cup patch had been fitted over it by a blacksmith when the vessel was at Amlwch, this cup patch being renewed at Port Dinorwic afterwards. It may be stated that the fitting of these cup patches over defective or leaky stays is a most dangerous method to adopt, and has frequently been the cause of explosion in the past.

I have now given you an epitome of all the boiler explosions that have occurred in this district during the last twenty-five years. I had hoped to have found a case of a copper steampipe giving way on board ship, as an object lesson of the defective arrangements made for expansion and vibration. Of course you all know that the powers-that-be recommend expansion glands. Personally, I don't like them. The packing gets burnt, and they either leak badly or get set fast, either of which is a bad thing. Also, they are usually placed in most awkward positions, where one gets scalded or grimed up when dealing with them. I prefer the pipe to have a nice free bend.

The best shape is when the pipe forms a complete circle, then the stress is distributed over the whole pipe. When arrangements are not made for the expansion and vibration to which pipes are subjected, they give way at the flanges, and this has been a common source of trouble at sea. Another point I should like to draw attention to is the method usually adopted in testing cast iron pipes by water pressure. They are commonly set up between two standards, one at each end, a joint being placed between each flange and its respective standard, and then the standards are either drawn or forced towards each other to tighten the joints. This puts the pipe in compression, an entirely different condition to what it will be in under working stresses, and a water test applied under these conditions gives no conception of its behavior when fixed up in place.

Again, in some cases flanges are screwed on to pipes, and this method of testing puts an entirely different stress on the screw to what it will have under working conditions, as the compression between the standards brings two particular faces of the threads into contact, whereas when two flanges are jointed together under working conditions the opposite faces of the threads are brought into contact.

Method Used by the Great Northern Railway Company to Clean Ash Pans to Comply with the Interstate Commerce Law.*

BY C. T. WALTERS †

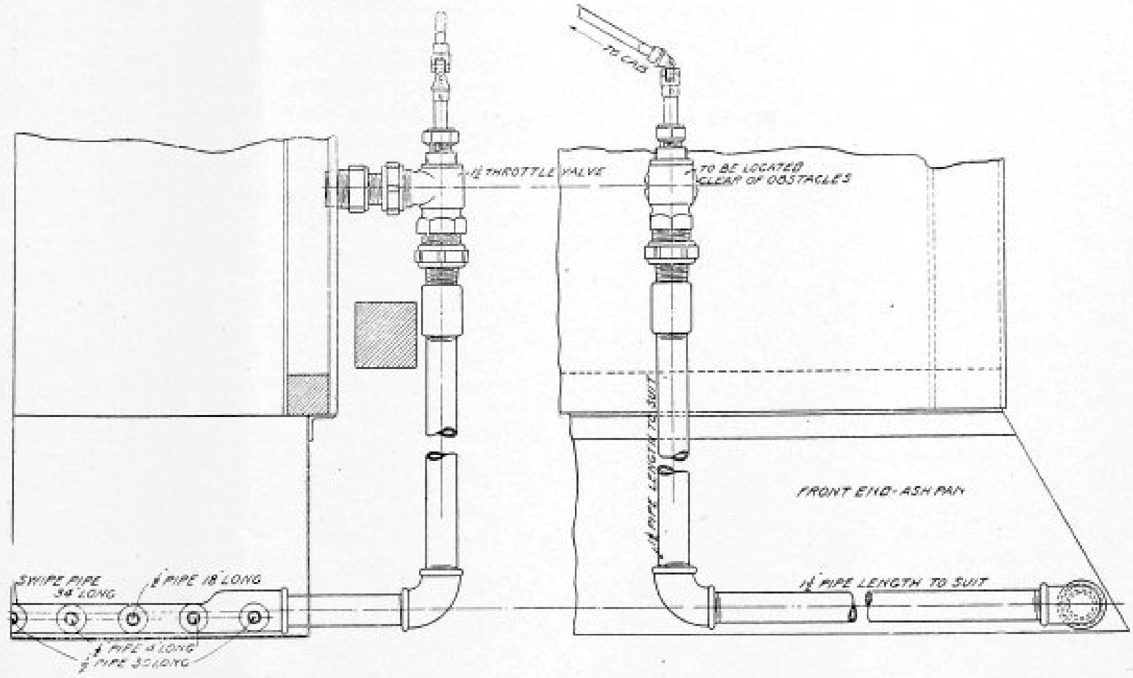
There are two styles of ash pans used by the Great Northern Railway, solid bottom and hopper ash pans. To clean the solid bottom ash pans, we used what is known as an ash pan swipe, which has been in use on the road for years, with very good success. The swipe is made of one cast iron column which is placed across in the pan from 4 inches to 6 inches from the front of the pan on the column, bases are cast 4½ inches apart, and tapped out from ½ inch gas pipe. The pipes are screwed into the column, pipes being 4 inches, 18 inches and 30 inches long. The number of ½-inch pipes depends on the width of pan. After you have placed the

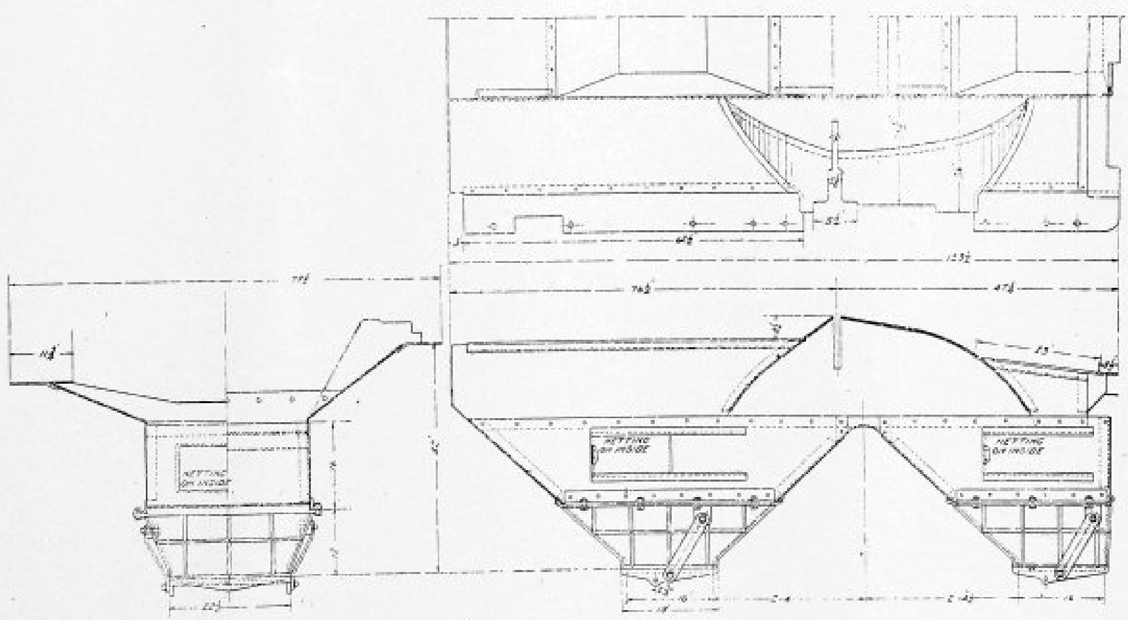
* From a paper read before the International Railway General Foremen's Association, 1910.

† General foreman, Great Northern Railway, Dale street, St. Paul, Minn.

swipe in the pan, cut a hole in the side of the pan to admit the one and one half inch pipe which is screwed into the column and connect it to the 1½-inch cock which is placed on the side of the firebox from 6 inches to 10 inches above the mud ring or in the most convenient place to get at. The handles to open the cock to blow out the pans are run into the cab. When necessary to clean the pan, open the back damper and then open the cock and you have a clean pan. It is not necessary to keep the cock open more than 20 or 30 seconds. This device is used only on the light power.

On the heavy power we use a drop bottom. The hoppers are bolted to the side frames which are hung from the mud ring. The doors of the hoppers are hung and connected by levers to a shaft bolted on the engine frame; on the shaft is a lever for opening and closing the doors of the pan. There is a quadrant notched to hold the doors closed. This style of pan is standard on our road, taking the place of the slide bottom pan which was in use for a short time, as the sildes were very hard to open, caused by ashes getting into the grooves. In cold weather the slides would freeze up causing delays.





ASH PANS WITH SWIPE AND DROP DOORS.

New Unit of Power.

At a recent meeting of the American Society of Mechanical Engineers, Prof. William T. Magruder proposed a new unit for measuring the power or capacity of a boiler. The new unit is termed a "boiler power," and is defined as 33,000 British thermal units of heating energy delivered by a steam boiler, steam main, or by a hot-water heating main, or the like, or added per hour to the feed water of a boiler or to the water of a hot-water heating system.

INDEXING SYSTEM FOR BOILER AND PLATE METAL SHOPS COVERING BLUE PRINTS, TRACINGS AND PATTERNS.—I.

BY EDWIN E. ROHRER.

This article is intended to lay down certain details whereby any boiler shop or plate metal firm can without consuming much additional time in their drafting room have a place for everything, and find everything in its place without being dependent on the memory of some of the older members of the firm for somewhere near the date of so and so, or without having to use the "Search and ye shall find principle."

True it is, some firms have methods to cover the above subject which need no improvement, and truly we feel they are wise, for it would be hard to make a conservative estimate of the time, etc., some firms lose in looking up complete data for duplicating an old contract, or in using their available material such as patterns on new work. We advise any interested reader to stop and think this matter over carefully if he has not already done so. On the other hand, we feel there are some firms who have outgrown their present systems, or have systems which in a few more years growth of business will be getting more and more complicated. We mention this last class for the reason that we believe there is no time like the present to get a system started which can be added to at all times, and in all ways, without having to be undone. In this connection the writer wishes to say that the method about to be described is practical, and has been tried and not found wanting.

First, we will deal only with the tracings, second with the blue prints as returned from the shop, and third with the patterns giving the data for the boiler shop and foundry.

The following sizes of tracings, which are well adapted to the different classes of work may be cut and given an index letter as shown:

Cut these sizes from 30-inch Linen	Cut these sizes from 36-inch Linen
F—9 by 14	O—12 by 17
T—12 by 14	P—12 by 34
J—12 by 28	G—17 by 34
K—14 by 20	U—18 by 34
L—20 by 28	V—24 by 34
N—28 by 42	

The above sizes are outside dimensions. We allow a ⅞-inch border all around, putting this on at the time we make up our tracing, at which time we also put the index letter on in the lower right hand corner, and upper left hand corner.

All tracings should be filed perfectly flat. You will therefore, require a cabinet of suitable dimensions for the above sizes of finished tracings. We recommend one of sectional design. The dimensions of a cabinet which will accommodate the above sizes nicely are 48 inches wide by 36-inches deep by 44-inches high made in two equal sections. Each section contains five drawers. No drawer should be less than 3 inches deep. Make a layout of your cabinet drawers, and have some of them partitioned off to accommodate the different sizes, for example:—you can sub-divide one drawer to take in the K-L-O-F sizes. This, however, is left to your judgment and you can decide how many drawers, and sub-divisions of certain sizes you will require. It is well to allow about 1 inch along the one side, and a half inch along the other side so that, as a sub-division fills up with tracings you can get at the one corner readily. The drawers 3 inches deep as above called for will each accommodate two hundred tracings in each sub-division.

We find it good practice to keep our casting details on two sizes and have selected the O and G size tracing. The G size prints you will note may be folded once and will then be the same size as O. This point, however, is entirely left to your judgment.

It is now necessary for you to classify the work you are handling, that is all details of it. We give below a classification using different groups of letters so that each set will be about equally divided.

A, B.—Anchor Plates, Ash Pans, Astragals, Brackets, Base Plates, Buck-stays, Bosh Jackets.

C, D, E.—Cupola Shells, Cinder Notches, Connecting Rods, Dampers, Die Blocks, Dished Heads, Door Plates, Elbows, Evaporators, Explosion Pipe.

F.—Flanges (all kinds), Former Blocks, Fire Doors.

G, H.—Gears (all kinds) Grates, Gas Pipe, Girders, Horizontal Boilers, Hangers, Hand-hole Plates.

I, J, K, L, M.—Jacketed Tanks, Water Jackets, Kilns, Kettles, Inlet Castings, Marine Boilers, Man-hole doors and frames, Ladles, Liners, Lathes (repairs).

N.—Nozzles (all styles.)

O, P, Q, R.—Outlet castings, Pipe, Platforms, Punch (repairs,) Rollers, Reinforcing Plates, Retorts.

S.—Stacks (Bell bottom and straight), Spuds, Separators, Stuffing Boxes, Steam Drums.

T.—Tube sheets, Tube Lay-outs, Tanks, Tuyere Blocks.

U, V, W, X, Y, Z.—Wall Plates, Wagon Bodies, Worm Wheels, Vertical Boilers, Uptakes, Yokes.

The system as so far outlined has required only the cabinet for your tracings. The next and last requirement is a Card Index, and a small cabinet for same. This may be of standard design. Purchase cabinet with at least one more drawer than you have classification, unless your business is such that you will not have sufficient cards in one classification to warrant the use of one drawer. If this is the case cut down the number of your drawers as you see fit, and place different classifications together. The one extra drawer is required to keep your index cards in, which you have already marked in the upper right hand corner with the letter designating the size tracing, and also the number of tracings. These cards are written up in advance, and always kept together in this index drawer. For example, you finish a K size tracing, and go to your index drawer and find that the next K number is 124. You then remove this card from the index drawer, and mark K—124 on your tracing, at the lower right hand corner, and upper left hand corner. Keep the card in your possession until it has been written up giving a brief description of what you have drawn on tracing K—124. It is then filed under its regular classification. For instance, if you have completed a drawing of a tank, place card in the T—drawer, or if your drawing shows a horizontal boiler put your card K—124 in the H—drawer under that classification. Often you will have several different parts detailed on one tracing. In this case write up a card for each part, that is, separately classified.

From the above explanation you will readily see that the letter designating the size of your tracings has nothing to do with your classification of parts and details.

The cards should not be less than 5 inches by 3 inches and all cards should be typewritten for permanent record. The cards in the drawers should be kept well sub-divided so you can readily find the size flange, or nozzle you are looking for without going through a great number of cards. There is no limit to sub-divisions you may make with your index cards.

In addition to the above we keep an index for the purpose of marking down under the different classifications any specials parts, or items we may have from time to time, and in this way are able to tell at a glance just where we can find the card for same. This index is simple consisting of a few sheets of paper with the different articles that are under the different classifications. You will find there is often some doubt as to which classification a certain part belongs, and therefore, in having this sheet index you can tell at a glance where to look for it. In brief this sheet index is a kind of "When in doubt consult me" part of the entire system.

With the above suggestions you should be able to arrange a system to suit your needs, as far as filing your tracings is concerned, and have something you can always add to.

A subsequent article will deal with the prints as returned from the shop and also the pattern system.

(To be continued.)

TEST OF BOILERS AT THE EVERETT MILLS.

The power house of the Everett Mills, of Lawrence, Mass., is equipped with Manning Boilers and Taylor Gravity Underfeed Stokers. In order to determine the commercial efficiency of the boilers and stokers, Mr. Robert Amory, Jr., and Mr. D. L. Smith conducted a series of tests, which are interesting in that the boilers were operated at about 150 percent of the builders' rating. Four tests were run in order to get average results. Of these tests the first was of five hours duration, the next two of 10½ hours, and the third 15½ hours. The results recently published in detail by the American Ship Windlass Co., manufacturers of the Taylor Stoker, are given here in abridged form.

In commenting on these tests Mr. Charles H. Manning, consulting engineer, states that on the whole the plant shows very good efficiency, especially when the 50 percent overload is taken into consideration, and also the fact that the plant was run by men of short experience with the stokers.

In these tests no attempt was made to get the best possible results as it was desired to find out just what the plant would do in ordinary service. This is shown by the methods of banking the fires and the fact that the tubes were not especially clean before the tests. Unfortunately the tubes were much clogged with soot causing a high flue temperature. As the fires during the tests were smokeless, it is presumed that the soot was due to the method of banking the fires at night. The fires were then burned very low, and from midnight until morning were spread with coal by hand so that in the early morning the fires were very green, which probably caused the deposit of soot on the cooler surfaces of the boiler.

CALORIFIC VALUE OF FUEL.

Calorific value by oxygen calorimeter, per lb. of dry coal	14,490 B. T. U.
Calorific value by oxygen calorimeter, per lb. of combustible	15,580 B. T. U.

LOCATION OF THE POINT OF WATER DELIVERY.*

BY H. M. BROWN †

The keen competition between the great railway systems of the country has resulted in the buying of large locomotives and the hauling of long, heavy trains, increasing the fuel consumption to such an extent that it is the heaviest expense of the railway companies. Another and more important result is the short duration of the staybolts and the flues, due to the water being put into the boiler at such a low temperature when the boiler is forced to its greatest efficiency, and has led to a vast number of experiments as to the best point of delivery to obtain a saving in fuel and to eliminate flue, staybolt and sheet failures.

If it were possible to feed an ordinary locomotive boiler with an injector with water under high temperature, it would not, in my opinion, signify much as to what point the water was delivered into the boiler; but as it is not possible to get satisfactory work out of an injector with water at a temperature much above 100° F., it is best, I believe, to deliver water at a point as far removed from the fire-box as it is possible to have it, and also deliver it at a point high up, if not on top of the boiler. The old (and generally accepted) practice of introducing the feed water into the boiler below the high water level, still prevails in the majority of cases, although in some cases the water is introduced into the steam space of the boiler, particularly where check valves of the Phillips pattern are used, on top of the boiler.

We have applied to a number of locomotives on our road the above mentioned type of boiler check on top of the boiler and as close as possible to the front flue sheet, and is, in our

* Paper read before the International Railway General Foremen's Association, Cincinnati, May, 1910.
† Asst. M. M., Chesapeake & Ohio R. R., Hinton, W. Va.

	WATER.				WATER PER HOUR PER BOILER.			HORSEPOWER PER BOILER.			ECONOMIC RESULTS.			
TEST NO.	Total Weight of Water Fed to Boiler Pounds.	Water Actually Evaporated Corrected for Quality of Steam.	Factor of Evaporation.	Equiv. Water Evap. into Dry Steam from and at 212 Degrees.	Water Evap. per Hour, Corrected for Quality of Steam.	Equivalent Evaporated per Hour from and at 212 Degrees.	Equiv. Evap. per Hour, from and at 212 Deg. per Sq. Foot of Heating Surface.	Horsepower Developed.	Builders' Rated Horsepower.	Percentage of Builders' Rated Horsepower.	Water Apparently Evap. under Actual Conditions per Lb. of Coal as Fired.	Equiv. Evap. from and at 212 Degrees per Lb. of Coal as Fired.	Equiv. Evap. from and at 212 Degrees per Lb. of Dry Coal.	Equiv. Evap from and at 212 Degrees per Lb. of Combustible.
1	67,081	67,081	1.140	76,456	6,708	7,646	4.89	221.6	150	147.4	9.86	11.24	11.46	12.24
2	143,092	143,092	1.148	164,320	6,814	7,825	5.01	226.8	150	150.8	9.10	10.45	10.66	11.40
3	143,965	143,965	1.144	164,760	6,855	7,846	5.02	227.4	150	151.4	9.24	10.57	10.78	11.57
4	210,173	210,173	1.146	240,880	6,780	7,770	4.97	225.2	150	150.1	9.26	10.63	10.82	11.56

	ANALYSIS OF DRY GASES.				CALCULATIONS FROM GAS ANAL.			HEAT BALANCE.					
TEST NO.	Carbon Dioxide, CO_2	Oxygen, O.	Carbon Monoxide, CO.	Nitrogen, N by Difference.	Pounds of Air per Pound of Combustible.	Pounds of Air per Pound of Carbon.	Dilution, Percent. Excess Air.	Heat Absorbed by Water, Percent.	Heat Lost in Flue Gases, Percent.	Heat Lost by Incomplete Combustion, Ashes, Percent.	Heat Lost by Evaporation of Moisture in Coal, Percent.	Heat Lost by Radiation, etc., Percent.	Total.
1	10.4	7.8	0	81.8	16.37	20.95	81.0	76.38	14.72	.17	.97	7.76	100
2	13.32	7.03	0	79.65	13.66	17.50	46.5	71.03	12.90	.76	.97	14.34	100
3	11.8	7.7	0	80.5	15.70	18.90	58.5	71.85	13.70	.67	.97	12.81	100
4	12.4	7.3	0	80.3	15.03	18.01	56.5	72.12	13.10	.64	.97	13.17	100

opinion, the best point of water delivery, because the water enters into the steam space of the boiler, passing through such a high temperature, is heated to a much higher degree than is otherwise the case, thus preventing materially the difference of temperatures at various points on the boiler plates. This tends to avoid the injurious effects of expansion and contraction to a much greater degree than if the water was delivered at or near the bottom of the water space of the boiler.

This has been satisfactorily proven by the use of the Phillips check, and a material saving in the consumption of coal has been effected by introducing the feed water into the steam space. That the old practice has been retained for such a long time is probably due to the (mistaken) idea that the injector will not work properly if the delivery is connected to the steam space of the boiler.

The principal advantage claimed for the Phillips check is that it is not connected with the water, and thus not likely to corrode easily, which will result in calling for less frequent repairing; it will also remain much longer in good working condition without re-grinding or re-setting, materially reducing the cost of maintenance. Another very important feature is, that should it become necessary to grind or repair the checks, not being in the water space, only the steam need be blown off and the fire banked, and repairs can be made, which greatly facilitates the dispatching of engines. We find that the use of the check results in a very heavy deposit of mud and scale around the end of the flues and around the dry pipe, making it absolutely necessary to instal near the check and on each side, wash-out plugs to enable us to loosen and wash out the scale and deposit.

While there are a great many advantages to be derived from the use of a check of the above pattern, one of the greatest difficulties that is encountered, and a very serious one, is the fact that it is almost an impossibility to keep the joint between the check and plate on the barrel of the boiler tight, so there will not be a continuous leak around the check, which not only results in the rotting out of the jacket, but is a continual annoyance by keeping the sand wet.

On the last fifty engines we received they were equipped with checks of this pattern, and have been one continual source of trouble from this cause. The trouble, in my opinion, is due to having a heavy wrought iron branch pipe; the expansion from this pipe tends to break the joint, causing the check to leak and run down over the boiler and the steam to sweat the sand box, resulting in delays and, in some instances, failures due to the sand not running.

With the feed water entering the boiler on a line with the running board, a few feet back from the front flue sheet, as is the common practice, and the water being very much cooler than the water in the boiler, it must go to the bottom and finds its way to the lowest point, which brings it to the back flue sheet and around the lower flues, causing these flues to contract excessively and resulting as we commonly find it, the lower flues leaking earlier and more often than the upper.

We have been experimenting with a high-pressure pump arranged on one of our through freight engines, the pump utilizing a portion of the exhaust, combining the steam with the water from the tank and places the water in the boiler at about 280° to 300° at the mud ring, and has proven to be a great success as far as the test we have conducted, which has not been thorough enough to warrant a further application at present. We have been enabled to save a great amount of coal, and on the engine on which it was tried has not had a staybolt fracture or have the flues given any trouble whatever since its application. I regret that I am unable to give more complete data on account of the test not having been as yet completed.

Therefore, I would say that the best point in a boiler to deliver the feed water is the highest point at which it can be introduced without causing the engine to work moist steam.

(ABSTRACT OF REPORT BY A. F. BRADFORD.)

The location of the point of water delivery in a boiler has until recently been little thought of, and only until the check valve was placed above the water line was there much discussion on this subject. One place where I think the water should never enter the boiler is near the fire-box, as this is the hottest part of the boiler and the forcing of cold water against the extremely hot surfaces would cause considerable damage, resulting in cracked sheets.

At the present time many roads are experimenting with the method of injecting the water into the boiler above the water line, the injected water being sprayed in and by the time it reaches the water line it is hot. It is readily seen that by this method there will be no trouble with the flues on account of forcing the cold water in against them, but will the boiler steam as well and operate as economical as where the water is fed in below the water line? Some say the engines steam better and also that it is more economical. As for steaming, I cannot say, but I should think that the steam would be of poorer quality and also that more economy is gained by placing the feed water inlet below the water line on the side of the boiler back of the flue sheet. The engines on the P. & E. Division of the C. C. C. & St. L. Ry. are fed in this manner and no trouble whatever has been found with the flues. A shield or box is placed on the inside of the boiler over the feed water inlet, and the injected water instead of coming in direct contact with the flues in a cool condition, is forced upward and is warmed thoroughly before striking them. In this manner a better circulation is obtained, for the injected water is first forced up, then as the warmer water from below comes up, the cooler water goes down, giving a good circulation and causing the boiler to steam better.

By feeding the water in below the water line a better quality of steam would be obtained; for if the cold water were sprayed in the steam, it would make the steam wet or of poor quality, and dryness of steam is quite a factor in the operation of a locomotive. Even if the spray is not placed close to the steam dome, it is plainly visible that the steam would not be of the same quality as if no water were mixed with it.

We have an engine in the shop which is being equipped with a double check spray feed, placed on top of the boiler; and owing to the fact that there are no other engines on this division so equipped, I can give no data as to their performance. With our present method of feeding the water in the boiler on the side of the front sheet back of the flue sheet, and placing a shield inside of the boiler to force the water upwards and prevent it from striking the flues, no trouble whatever has been encountered.

We all know that the hot steam forces the cold water to the bottom, causing the lower flues to contract, thereby causing them to leak, hence this is why we apply the shield or box on the inside of boiler to force the injected water to the top water level.

I should like to have this subject thoroughly discussed, as I would like to be enlightened as to the best location of the point of water delivery, for at the present time I am doubtful as to the best location.

The Pennsylvania Railroad System now has in service on its lines 704 all-steel passenger cars and 1,284 more have been ordered. In June, 1906, it was announced that all future additions to passenger equipment on the Pennsylvania system would be of all-steel construction.

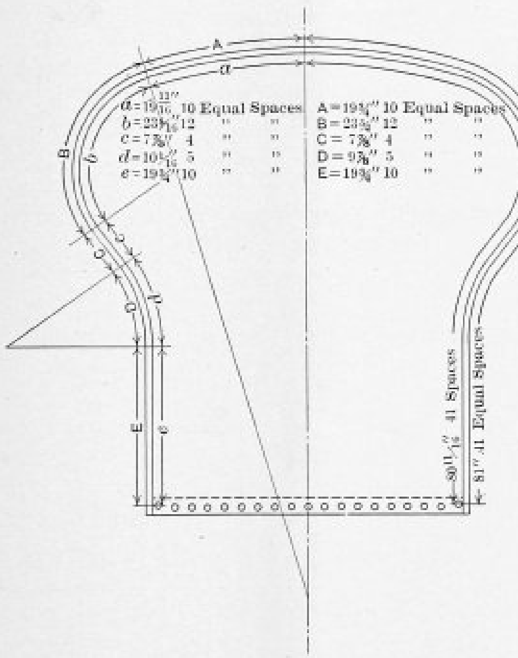
NOTES ON THE MEASURING WHEEL.

BY W. E. O'CONNOR.

The sketch shows the end elevation of a fire-box for which it is desired to lay out the shell plates, spacing in the rivet holes, etc. This sheet, of course, will be laid out flat, and the rivet holes must be spaced in such a way as to agree with those in the heads. In this type a fire-box the contour for the flange line of the heads is composed of arcs of different radii in connection with tangents. A common though not particularly expeditious way of developing the shell plate for such a design is as follows:

When the heads are flanged and annealed, the rivet holes are then properly spaced on the flange and center marked. Then with a flexible stick of the same gage thickness as the shell plate, the rivet spacings are lifted and transferred to the shell plates.

Although the foregoing method is accurate in many shops the 24-inch graduated measuring wheel has displaced the flexible measuring stick, and by means of this device the work can be done more rapidly. To do this work with the wheel entails no complicated method of procedure, and it can be mastered by a little perseverance and practice on the part of the student.



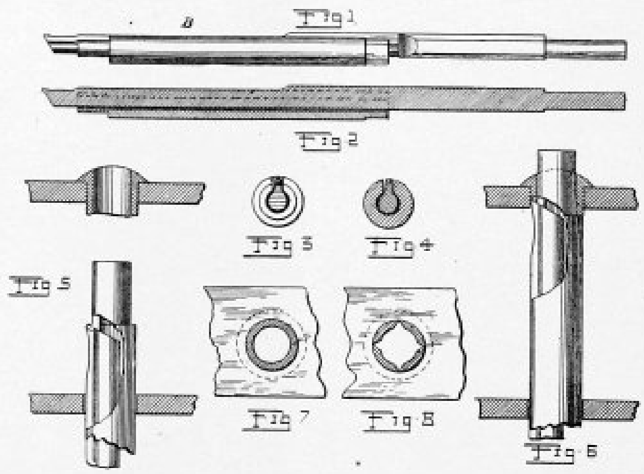
END ELEVATION OF FIRE-BOX.

When the heads are laid out complete for trimming, flanging, etc., in the straight sheet, it is customary to draw an auxiliary parallel line circumscribing the flange line at a given distance from it equal to one-half the thickness of the shell plate plus 1-16 inch, which allows for an easy fit when assembling the parts. The radial lines are extended indefinitely, as shown on the sketch, to mark the several divisions of the arcs and tangents. It is good practice when traveling the neutral and flange lines with the measuring wheel in order to get the difference in the lengths of the corresponding arcs for future reference, to have at hand a suitable pencil sketch on which to note the readings on the wheel when passing over the radial lines.

Assuming that the data for the layout have been ascertained, the next procedure is to lay out the shell plate. Commence by wheeling either side of the center line 81 inches. Since the plate is symmetrical on each side of the center line, and since both heads coincide in parts, it is only necessary to divide 81 inches into forty-one equal spaces on a suitable chalked stick and transfer these spaces on to the plate on either side of the center line. The heads can then be laid out by wheeling from the center line the lengths of the several divisions, as shown with the rivet spacing, etc.

A STAYBOLT CUTTER.

A new cutting tool for removing the ends of broken stay-bolts in locomotive boilers has recently been patented by William Smith, of Peshtigo, Wis. The object of the invention is to provide a simple, strong, and efficient cutting tool, by means of which the ends of broken stay-bolts can be removed from locomotive boilers expeditiously, and at the expense of little time and labor, and also to provide means whereby this operation can be effected when it is possible to



operate at one side only of the boiler sheet in which the broken end is located.

Fig. 1 shows the side elevation of the tool, and Fig. 2 a longitudinal section. Fig. 3 is an enlarged end elevation, and Fig. 4 an enlarged transverse section. Fig. 5 is a cross-section of the inner and outer sheets of the boiler, showing the end of a broken stay-bolt, and a partial view of the tool. Fig. 6 is a similar view, showing the tool in position to cut. Fig. 7 is a cross-section of the broken bolt in Fig. 5, and Fig. 8 is a similar view, showing the broken end after it has been cut by the tool.

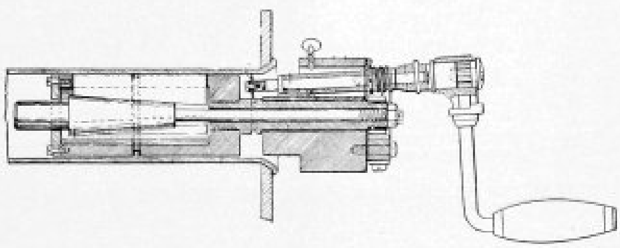
The manner of cutting out the broken end of the bolt is as follows:

The end of the fractured bolt has a hole drilled through it, which is of the same diameter as the small end of the sheath of the cutter. This constricted end is then inserted in the hole in the bolt, and the cutter member is operated to cut the metal surrounding the hole, as shown in Fig. 4. When one cut has been formed, the sheath is turned part way round and another cut is taken. In this way the bolt can be severed into a number of parts, which permits it to be easily knocked out of place.

The advantage of this tool, of course, lies in the fact that it furnishes a means of reaching the broken ends of bolts located behind the frame of the locomotive or in inaccessible positions. It is well known that stay-bolts in locomotive boilers usually fracture near the inner side of the outside boiler sheet. When the broken bolt is located behind the frame of the locomotive or other obstructed place, it is necessary to drill the bolt above the fire-box and drop it out of the way, whereupon the stub remaining in the outside sheet is centered with a long center punch and a hole bored through it. The part of the drilled bolt remaining in the sheet is then cut out with a round nose chisel. This, as all boiler makers know, is a difficult job to do, and it sometimes happens that the sheet is grooved in the operation, causing trouble. The tool which has just been described is designed to overcome this difficulty.

Young's Patent Tube Cutter.

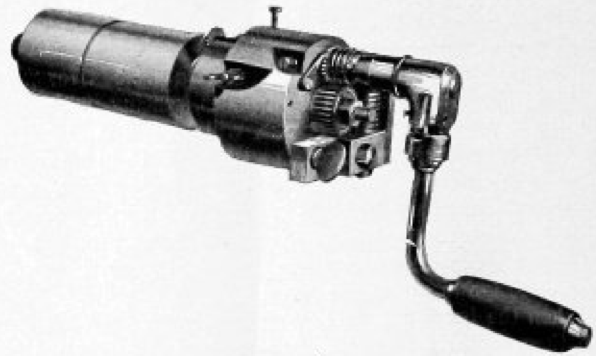
The illustrations show an external and sectional view of a new tube cutter, which is being manufactured by O. R. Young, Riverhead, N. Y. This cutter works on the principle of removing a very small section of the tube instead of



SECTIONAL VIEW OF TUBE CUTTER.

forcing the tube apart with a bevel wheel cutter, as is commonly done in tools of this type.

Referring to the sectional view, which shows the cutter inserted in the tube which is to be cut; to the body of the cutter, which holds the cutter in place in the tube, is attached a spindle upon which the cutter head carrying the saw



EXTERIOR OF YOUNG'S TUBE CUTTER.

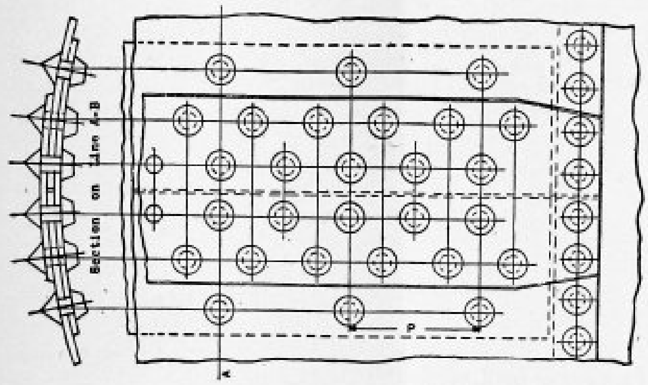
rotates; a sleeve is pivoted at its outer end, which carries the saw arbor; the saw is a small metal slitting saw, which cuts the tube. It is claimed that on account of the cutting action of the saw on the tube, the cut being from the outside to the inside, it will cut the tube just inside the head or manifold without enlarging it, or leaving any burr on the outside, so that the tube can be removed easily through the same hole in which it was expanded. The tube cutter can be operated by hand, as shown, or driven by power through a flexible shaft. Its action is claimed to be very rapid when driven by a flexible shaft.

TABLES OF EFFICIENCIES OF TRIPLE RIVETED BUTT STRAP JOINTS.

The Massachusetts Board of Boiler Rules has recently issued a pamphlet containing tables of efficiencies in per-

TABLE No. I.
T. S. = 55,000, 57,000 and 58,000 pounds.

Diameter of Rivet Hole.	Thickness of Plate.																	
	1/4"	9/32"	9/32"	5/16"	5/16"	5/16"	11/32"	11/32"	11/32"	3/8"	13/32"	7/16"	15/32"	1/2"	17/32"	9/16"	19/32"	5/8"
	Thickness of Butt Strap.									R = Any thickness allowed by par. 13, sec. 4, part 3 of the Rules.								
	1/4"	1/4"	9/32"	1/4"	9/32"	5/16"	1/4"	9/32"	5/16"	R.	R.	R.	R.	R.	R.	R.	R.	R.
	T. S. = 55,000 pounds.																	
11/16"	6 9/16"	6 7/16"	6 7/16"	6 9/16"	6 9/16"	6 5/16"	6 1/4"	6 1/4"	6 1/4"									
3/4"	7 3/16"	7 1/16"	7 1/8"	6 9/16"	7"	7"	6 13/16"	6 7/8"	6 7/8"	6 13/16"	6 3/4"	6 11/16"						
13/16"	.....	.....	.....	7 1/2"	7 11/16"	7 11/16"	7 7/16"	7 9/16"	7 9/16"	7 7/16"	7 3/8"	7 5/16"	7 1/4"					
7/8"	.....	.....	.....	8 1/8"	8 1/4"	8 3/8"	8"	8 3/8"	8 1/4"	8 1/8"	8"	7 15/16"	7 7/8"	7 13/16"				
15/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8 9/16"	8 1/2"	8 7/16"	8 3/8"	8 5/16"		
1"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 1/16"	9"	8 15/16"	8 7/8"	
1 1/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 5/8"	9 9/16"	9 1/2"	9 7/16"
1 1/8"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10 1/8"	10 1/16"
	T. S. = 57,000 pounds.																	
11/16"	6 5/16"	6 5/16"	6 3/16"	6 1/4"	6 1/8"	6 3/8"	6 1/16"	6 1/16"	6 1/16"									
3/4"	7"	6 7/8"	6 7/8"	6 11/16"	6 3/4"	6 3/4"	6 5/8"	6 11/16"	6 11/16"	6 9/16"	6 1/2"							
13/16"	.....	.....	.....	7 1/4"	7 7/16"	7 7/16"	7 5/16"	7 5/16"	7 5/16"	7 1/4"	7 1/8"	7 1/16"	7"					
7/8"	.....	.....	.....	7 13/16"	8"	8 1/16"	7 3/4"	7 7/8"	7 15/16"	7 7/8"	7 3/4"	7 11/16"	7 5/8"	7 9/16"				
15/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8 5/16"	8 1/4"	8 3/16"	8 1/8"			
1"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8 13/16"	8 3/4"	8 13/16"		
1 1/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 5/16"	9 1/4"	9 3/16"	
1 1/8"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 13/16"	9 3/4"
	T. S. = 58,000 pounds.																	
11/16"	6 1/4"	6 1/8"	6 1/8"	6"	6"	6"	5 15/16"	5 15/16"	5 15/16"									
3/4"	6 7/8"	6 3/4"	6 3/4"	6 5/8"	6 5/8"	6 5/8"	6 1/2"	6 9/16"	6 9/16"	6 1/2"	6 7/16"							
13/16"	.....	.....	.....	7 5/16"	7 5/16"	7 7/16"	7 1/16"	7 3/16"	7 3/16"	7 1/8"	7 1/16"	6 15/16"						
7/8"	.....	.....	.....	7 3/4"	7 7/8"	7 15/16"	7 5/8"	7 3/4"	7 7/8"	7 3/4"	7 5/8"	7 9/16"	7 1/2"	7 7/16"				
15/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8 3/16"	8 1/8"	8 1/16"	8"			
1"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8 5/8"	8 9/16"	8 9/16"		
1 1/16"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 1/4"	9 1/8"	9 1/16"	
1 1/8"	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9 13/16"	9 5/8"



TRIPLE-RIVETED BUTT JOINT.

centages of butt and double strap joints, computed by William W. Ramsey, State Inspector of Boilers. The total number of tables in the pamphlet is eighty-six and their use will result in an immense saving of time and labor to all who are identified with boiler design, construction or inspection.

TABLE No. II.

All joints given in this table will fail at B.

B = Strength of plate between rivet holes in the outer row.

Pitch of Rivets in Outer Row	Diameter of Rivet Hole.							
	11/16"	3/4"	13/16"	7/8"	15/16"	1"	1 1/16"	1 1/8"
5"	86.2	85.0						
1/16"	86.4	85.1						
1/8"	86.5	85.3						
3/16"	86.7	85.5						
1/4"	86.9	85.7	84.5					
5/16"	87.0	85.8	84.7					
3/8"	87.2	86.0	84.8					
7/16"	87.3	86.2	85.0					
1/2"	87.5	86.3	85.2	84.0				
9/16"	87.6	86.5	85.3	84.2				
5/8"	87.7	86.6	85.5	84.4				
11/16"	87.9	86.8	85.7	84.6				
3/4"	88.0	86.9	85.8	84.7				
13/16"	88.1	87.0	86.0	84.9				
7/8"	88.2	87.2	86.1	85.1				
15/16"	88.4	87.3	86.3	85.2				
6"	88.5	87.5	86.4	85.4	84.3			
1/16"	88.6	87.6	86.5	85.5	84.5			
1/8"	88.7	87.7	86.7	85.7	84.6			
3/16"	88.8	87.8	86.8	85.8	84.8			
1/4"	89.0	88.0	87.0	86.0	85.0	84.0		
5/16"	89.1	88.1	87.1	86.1	85.1	84.1		
3/8"	89.2	88.2	87.2	86.2	85.2	84.3		
7/16"	89.3	88.3	87.3	86.4	85.4	84.4		
1/2"	89.4	88.4	87.5	86.5	85.5	84.6	83.6	
9/16"	89.5	88.5	87.6	86.6	85.7	84.7	83.8	
5/8"	....	88.6	87.7	86.7	85.8	84.9	83.9	
11/16"	....	88.7	87.8	86.9	85.9	85.0	84.1	
3/4"	....	88.8	87.9	87.0	86.1	85.1	84.2	
13/16"	....	88.9	88.0	87.1	86.2	85.3	84.4	
7/8"	....	89.0	88.1	87.2	86.3	85.4	84.5	
15/16"	....	89.1	88.2	87.3	86.4	85.5	84.6	
7"	....	89.2	88.3	87.5	86.6	85.7	84.8	83.9
1/16"	....	89.3	88.4	87.6	86.7	85.8	84.9	84.0
1/8"	....	89.4	88.5	87.7	86.8	85.9	85.0	84.2
3/16"	....	89.5	88.6	87.8	86.9	86.0	85.2	84.3
1/4"	....	89.6	88.7	87.9	87.0	86.2	85.3	84.4
5/16"	....	89.7	88.8	88.0	87.1	86.3	85.4	84.6
3/8"	....	89.8	88.9	88.1	87.2	86.4	85.5	84.7
7/16"	....	89.9	89.0	88.2	87.3	86.5	85.7	84.8
1/2"	....	90.0	89.1	88.3	87.5	86.6	85.8	85.0
9/16"	....	....	89.2	88.4	87.6	86.7	85.9	85.1
5/8"	....	....	89.3	88.5	87.7	86.8	86.0	85.2
11/16"	....	....	89.4	88.6	87.8	86.9	86.1	85.3
3/4"	....	....	89.5	88.7	87.9	87.0	86.2	85.4
13/16"	....	....	89.6	88.8	88.0	87.2	86.4	85.6
7/8"	....	....	89.6	88.8	88.0	87.3	86.5	85.7
15/16"	....	....	89.7	88.9	88.1	87.4	86.6	85.8
8"	....	....	89.8	89.0	88.2	87.5	86.7	85.9
1/16"	....	....	89.9	89.1	88.3	87.5	86.8	86.0
1/8"	....	....	90.0	89.2	88.4	87.6	86.9	86.1
3/16"	....	....	....	....	88.5	87.7	87.0	86.2
1/4"	....	....	....	....	88.6	87.8	87.1	86.3
5/16"	....	....	....	....	88.7	87.9	87.2	86.4
3/8"	....	....	....	....	88.8	88.0	87.3	86.5
7/16"	....	....	....	....	88.8	88.1	87.4	86.6
1/2"	....	....	....	....	88.9	88.2	87.5	86.7
9/16"	....	....	....	....	....	88.3	87.5	86.8
5/8"	....	....	....	....	....	88.4	87.6	86.9
11/16"	....	....	....	....	....	88.4	87.7	87.0
3/4"	....	....	....	....	....	88.5	87.8	87.1
13/16"	....	....	....	....	....	....	87.9	87.2
7/8"	....	....	....	....	....	....	88.0	87.3
15/16"	....	....	....	....	....	....	88.1	87.4
9"	....	....	....	....	....	....	88.2	87.5

Tables I. and II., taken from this pamphlet, show the efficiencies in percentages of butt and double strap joints, triple riveted, in which the pitch of rivets in the outer row is twice the pitch of rivets in the second and inner rows. Table No. I. gives the greatest pitch of rivets in the outer row with which the joint will fail at the strength of plate between the rivet holes in the outer row. If the pitch of rivets in the outer row is not in excess of that found under T. S. thickness of shell plate, thickness of butt strap and opposite the diameter of rivet hole in Table No. I., the efficiency in percentage will be found in Table No. II. If, however, the pitch of rivets in the outer row is in excess of that given in Table No. I., or is not given, the joint will fail in some manner other than at the strength of plate between the rivet holes in the outer row and will require to be computed in the usual manner for the strength of a joint, the point of failure of which is not determined.

HEAT TREATMENT OF STEEL.

BY J. F. SPRINGER.

The study of the characteristics and behavior of different kinds of steel is an enormous problem. It is proposed to set forth in this article some of the results which Science has attained as she worked at the question. The warning is given, however, that we must remember that the principles and directions are to be regarded as general. He who uses them must bear in mind that the particular steel he has in his shop may, because it contains some impurity or for some other minor reason, fail to respond precisely as expected. At the same time he must not throw the results away. The proper course is a middle one—take the scientific statements and conclusions as a guide and seek to find what are the small variations in temperature and the like which will give the expected and desired results.

Thus, suppose you seek to apply the scientific indications as to the temperature at which the smallest grain size is to be expected in the case of your particular steel having, say, a carbon precentage of 0.20. Your steel may contain some impurity or ingredient which affects this matter, so that the proper temperature may be a little different. How much different is something to be determined in your own shop. Scientists have not determined, and cannot be expected to, such matters for all possible varieties of steel, whatever the varying impurities may be. But they have been and are searching out the general facts at an enormous expense of time and labor.

GRAIN SIZE.

A piece of steel consists of multitudes of tiny crystals packed tightly together. In some cases the general appearance is very much like that of a slab of veined marble. That is, there will be a kind of network. Now the material in the "veins" which form the network is quite different from the material inclosed and thus separated into crystals or grains. In the steels having the lower carbon percentages the network is pure iron. The grains inclosed contain all the carbon. Now this network is very fine indeed as a rule. A grain inclosed may be no larger than .003 inch across, or even less. But the grain size varies tremendously. A grain may be half an inch across. Even in the same steel the grain size may be wonderfully different, depending upon the heat or mechanical treatment it has received. With the same steel the general rule is that the larger the grain size the weaker the steel. It can readily be seen, then, that this is a question to which we cannot well be indifferent. In fact, it is of the highest importance that we secure the very smallest size of grain we can. We shall then have secured—other things being equal—the very best quality possible with that particular steel.

If we heat a piece of steel to a pretty high temperature, say about 2,000 degrees F., and then let it cool without working, we shall find that it will have pretty large grains. Just what size will depend upon the carbon content and perhaps upon other ingredients. At all events the size will be quite large for this steel. The quality will therefore be much less than it is possible to obtain with the same piece of metal. If the heating had stopped short of 2,000 degrees, the grain size would have been less. In fact, down to a certain temperature, the less the steel is heated the better it is. And it doesn't matter particularly whether this is the first time the piece of steel has been heated or not. If we heat it slowly to a certain temperature within the range of grain variation, we shall get the grain size corresponding to that temperature.

RESTORATION OF STEEL.

Indeed, this is the great method of restoring steel that has been overheated and has consequently got large-grain size and the accompanying weakness. The steel is reheated to the region of smallest grain. The large grains break up and smaller ones form under the influence of the reheating process. But not altogether. Sometimes some of the large grains cling on for awhile. However, the general rule for low-carbon steels (*i. e.*, those having less than 0.90 percent carbon) is to heat them from some point below 1,274 degrees F. to a point above it. This point where the reheating is to stop varies with the carbon. If the steel has 0.50 percent carbon, we stop at 1,400 degrees, or a little above. For every 0.01 percent below 0.50 percent we add 5.04 degrees to 1,400 degrees to get the point at which to stop. Thus for 0.45 percent carbon steel we stop at $1,400 + 5 \times 5.04 = 1,425$ degrees. For 0.20 percent carbon steel the point of stoppage is $1,400 + 30 \times 5.04 = 1,551$ degrees. These points of stoppage are to be regarded as perhaps 10 or 20 degrees too low. For the exact temperature for particular varieties of steel, it will, of course, be necessary to experiment a little. To do this we need to know *for the particular steel* just what the smallest grain size is.

METCALF METHOD.

There is quite a simple method of determining the minimum size of grain. This is the "Metcalf Test." A bar of the steel, say 12 inches in length, is heated at one end until scintillation begins, the other end being still black. It may now be quenched or allowed to cool slowly—it does not matter which is done—when it may be cut into short lengths with a hack saw. We shall have at the points of the cuts various examples of the grain size corresponding to the various temperatures. These samples may then be suitably polished and put under the microscope. The grain size which is the smallest will be selected as the standard. The proper temperature of reheating may now be determined by heating a number of bars to the temperature indicated by calculation (as already explained) and to temperatures a little above and a little below. We find the one which matches our standard grain size and adopt the corresponding temperature. It will, of course, be necessary to employ some kind of a pyrometer, as the up-to-date shop is getting further and further from guesswork. By all means determine, once for all, by suitable experiment, the exact temperature for restoration by reheating. The foregoing temperatures apply to steels having 0.50 percent carbon or less.

If the steel contains more than 0.50 percent carbon we heat still from below 1,274 degrees. But instead of heating to 1,400 degrees, we heat to a lower point. We subtract 3.15 degrees for each 0.01 percent carbon above 0.50 percent. Thus, if the steel is 0.60 percent carbon it is ten times 0.01 percent above 0.50 percent. So we subtract 31.5 degrees from 1,400 degrees to get our reheating temperature. Thus for 0.60 percent carbon steel we reheat to 1,369 degrees, for 0.70 percent steel to 1,337 degrees, and so on. In practice these temperatures should probably be slightly exceeded—say 10 degrees.

If the steel is a tool steel (*i. e.*, contains more than 0.90 percent carbon), we simply reheat from a point below 1,274 degrees to a point above. For such steels, too, we may get the Metcalf samples by notching the 12-inch bar before heating, and then breaking it at the notches subsequently to cooling.

PRECAUTIONS.

If the significance of what has now been explained be understood it will readily be seen that if a piece of steel is reheated for the purpose of restoration, it is important that *all* parts be brought to the required temperature, and that no parts be heated much beyond it. To accomplish these results in practice care will be necessary. Thus, we may reheat the *exterior* to just the right point. But how about the *interior?* It may not yet have reached the best temperature of restoration—may, in fact, be considerably behind. If we heat the exterior to a higher point then we may really overheat it. If we stop and let inside and outside strike an average, this average will likely be below the required point. However, this difficulty may be met thus: Heat the piece so slowly that no part will be much beyond any other part. The heat should envelop the whole. Probably the very best results are obtainable by the use of a metal bath. By its use the piece can be prevented from getting overheated in any part.

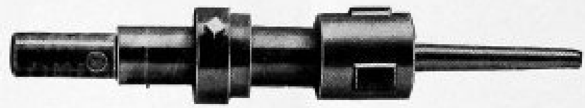
SHEET METAL PRACTICE.

In boiler work and other similar cases, heat is applied to parts, and they are thus often overheated, no doubt. If the steel is highly heated—that is, if it is heated above its point of restoration—then it will be more or less damaged. To illustrate this matter, suppose a blacksmith welds two parts of steel together. He has highly heated the regions next the weld, and so has produced a large grain size. Right at the weld, more or less restoration takes place from his hammering (as will later be explained). But off to the sides we have overheating and perhaps no kind of restoration. In other words the weld is strong, but to each side there may be weakness. It would seem advisable to reheat the whole, being careful not to exceed the proper temperature.

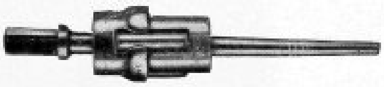
MECHANICAL RESTORATION.

When steel has been heated to a point above its minimum grain size, we may break the large grains up forcibly by hammering or other mechanical means. These grains, so it seems, not only break up but they reunite—or perhaps the particles never quite let go. At any rate, under the influence of mechanical treatment we are able to get a smaller grain size. This mechanical treatment may be forging or rolling. However, it should be remembered that we can hardly expect restoration at points where the influence of hammer or roll does not penetrate. In rolling it has been found that this penetration may be very little. It must be somewhat the same with forging. It would seem best to apply mechanical treatment continuously, if possible, from the moment of beginning to the finish. Further, it seems that mechanical treatment ought not to be continued below the point of minimum grain size. This appeals to our common sense. To break up or force about grains that are already as small as they can become would seem to produce only mischief. However, we must not be too sure as to this, as cold-forming processes seem to show that certain movements may be suffered with little or no detriment. The great difficulties with mechanical restoration are lack of penetration and frequent inapplicability to the whole overheated region. Reheating, on the other hand, may be made to reach all interior points and adjacent regions as well. If there is much work of the same kind with a particular steel, it would seem advisable to make comparative tests with and without mechanical treatment—using reheating alone. This whole matter merits the most careful attention and investigation on the part of those manufacturing boilers and

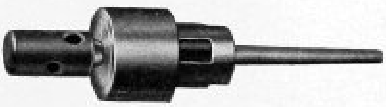
"Boss" Roller Expander (Hand Use)



Arch Flue Expander



Boss" Roller Expander (Self-Feeder)

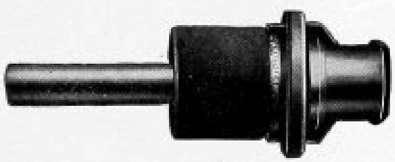


Universal Expander (Hand Use)

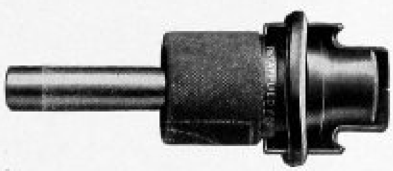
Universal Expander (Self-Feeder)

Removable Collar Expander (Hand Use)

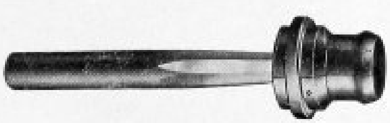
Removable Collar Expander (Self-Feeder)



Rapid Beading Expander



Rapid Beader Tool



Improved Sectional Expander

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Space here does not permit describing each in detail. If it did, we think we could easily convince you beforehand of the ability of any Faessler tool to withstand the hardest knocks of severe service and do first-class work under trying conditions.

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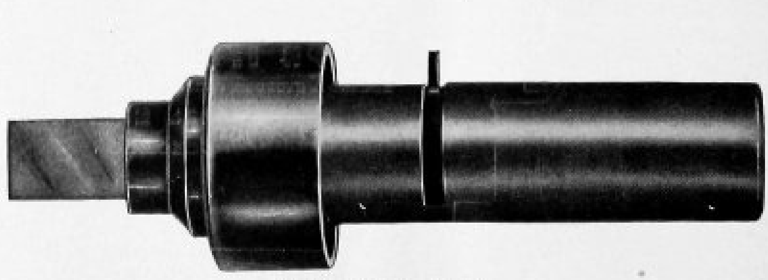


"Perfect" Flue Cutter

other apparatus which will have to undergo severe tensile stress.

Now, not only is this question of restoration an important one for the main work, but also for accessories. Thus suppose that rivets are highly heated for riveting. It is conceivable, of course, that some restoration takes place because of the mechanical treatment involved in the operation. But there are two objections to dependence on this: (1) Mechanical restoration should continue, so it seems, all the way down to the temperature of smallest grain; and (2) the whole rivet should be reached in a thorough manner. It would seem doubtful if either requirement is met.

Similar effects to those due to overheating have been observed in the case of very mild steel which has been exposed for a considerable time to the moderate temperature range between 930 and 1,380 degrees F. The steel meant here is that which has no more, say, than 0.15 percent carbon. It is said that the crystals grow to a great size and that the steel becomes weak. The phenomenon is known as "Stead's brittleness." Bradley Stoughton cites an instance: A wrought iron chain, which assisted in the support of a 50-ton ladle, suddenly broke through weakness brought about by the continued exposure to a temperature above 930 degrees. Life was lost in this instance. To restore such steel it should be heated to about 1,580 degrees F., or slightly above, if the carbon percentage is as much as 0.15. If the carbon content is lower yet then it should be heated somewhat higher. Thus for 0.10 percent carbon the reheating should be continued to 1,605 degrees F., or a little higher; for 0.05 percent carbon to 1,630 degrees, or a little higher. Chains, tie rods, boiler supports and the like—all articles of very mild steel which are exposed to prolonged heat ranging between 930 and 1,380 degrees—should be, we are assured, reheated once a week or once a month, or as often as needful.

THE USE OF THE MAGNET.

It is a remarkable property of steel that it loses its magnetic quality upon being heated sufficiently. The point of demagnetization varies somewhat with the carbon content. The magnetic quality does not depart gradually but rather suddenly. Now it so happens that the temperature at which this change takes place corresponds for steels having 0.40 or 0.50 percent carbon, or more, to the temperature of finest grain or to the temperature below which it seems generally inadvisable to mechancally treat steel. We are thus able—*for these steels*—to determine this critical point of temperature by a very simple means recommended by Stoughton. If we are forging such steel we continue to do so until it begins to be attracted by the ordinary horseshoe magnet sold for 5 and 10 cents. Thus we may be hammering a weld. This is all right, but we must stop when the metal at the point of hammering becomes magnetic. Again, we may be restoring some steel of the carbon content mentioned, desiring to produce the finest grain. We reheat until the magnet ceases to attract. We may heat a few degrees higher. But then we stop.

For steels having less than 0.40 percent carbon the rules are not quite so simple. And these are the steels in which the boiler maker is especially interested. If we are restoring metal which has been overheated, the condition when the magnet ceases to attract is—for such carbon contents—one of incomplete restoration. It seems that part of the material has become fine grained, but only part. However, the magnet is useful as showing that we are near the temperature of complete restoration. This temperature is higher and higher the less the carbon. But even for steel of no carbon the additional amount is only about 250 degrees F. So, then, to restore steel whose carbon content is less than 0.40 percent reheat until the magnet no longer attracts, and then continue to heat up the few additional degrees indicated by the carbon percentage. For every point below 40 carbon add 6.2 degrees. Thus for 0.20 percent carbon heat after the magnetic quality is gone for 124 degrees higher. This may, perhaps, be judged by the eye or from general conditions. If we are mechanically treating these low-carbon steels the appearance of the magnetic quality is notice that we should already have desisted.

BURNT STEEL.

There is a distinction between overheated and burnt steel. When steel has been heated to the point of scintillation it is scarcely to be regarded as merely overheated. It should be considered burnt and unfit for use. Burning does not take place unless the steel has been heated to a point near the melting point. Now the melting point varies greatly with the carbon content. The more carbon the more easily it is melted—the more easily burnt. If the carbon content is quite low the steel would have to be heated to quite a high temperature to burn it. The distinction between overheated and burnt steel is important, from the fact that overheated steel can usually be pretty thoroughly restored to its normal quality. It is scarcely safe to count upon restoration with steel actually burnt. If a steel is so mild that its carbon content is only about 0.20 percent, then it would ordinarily have to be heated to the neighborhood of 2,700 degrees F. in order to burn it.

ANNEALING.

The effects of hardening steel may be removed by heating, as is well known. It is, perhaps, not well known at what a moderate temperature this result may be secured. If the hardened metal be heated only to 1,100 degrees F. that will be sufficient. However, it is often desired not only to anneal but also to restore to the minimum grain size. Under such conditions the restoration accomplishes the annealing as well. But there are other cases where the fine grain has been produced by cold rolling or cold drawing or the like. Under such conditions it is recommended to anneal at the low temperature (about 1,100 degrees F.) in order to avoid spoiling any of the good effects of the cold working.

MECHANICAL STOKERS FOR LOCOMOTIVES.

At the forty-third annual convention of the American Railway Master Mechanics' Association, held in Atlantic City, June 20-22, the committee on mechanical stokers briefly referred to the progress and development of stokers which had been reported at previous conventions, and briefly described new stokers which had not been previously dealt with. The first one described was the Crawford stoker, which has been developed and placed in service on the Pennsylvania Railroad. This is a new stoker with a conveyor attachment from the tender. The entire mechanism is operated by a single steam cylinder. The coal is conveyed from the tender through an opening in the floor, and is then handled by a feeder and breaker sliding backward and forward in the direction of the center line of the tender. This is not a crusher, but it has a limited opening, and is provided to prevent large lumps from having access to the conveyor beneath. Inside of the conveyor, at 11 points, are placed rake fingers, operated from a bar above and extending nearly to the bottom of the trough, and having such a movement as to drag over the coal in moving backward and scraping the coal toward the locomotive in its forward movement.

From the conveyor the coal is led to a point directly beneath the deck plate of the locomotive back of the boiler and dropped into a space from which it is pushed under the mud-ring, and into two troughs placed longitudinally to the fire-box and below the surface of the grates. In the bottom of the troughs are additional feeders for conveying the coal to the middle or forward portion of the grate. The plunger, or feeder, first taking the coal feeds it principally to the back end of the grate and the additional feeders carry it forward. The arrangement of these feeders is such that their number can be increased so as to get the desired distribution of coal. The operation of the steam cylinder is controlled by a small valve in the cab, which is operated by the fireman.

This stoker has been in service on one of the Pennsylvania Class H-6B locomotives, and has made about sixty runs between Columbus and Dennison, Ohio. Out of these trips forty-three were made with no hand-firing whatever, and as much as 5,200 pounds of coal were fired per hour. Smoke from the locomotive was entirely absent while the stoker was in operation, except that smoke appeared at the stack when the fire was hooked or scraped and when the grates were shaken. The extent of the smoke under these circumstances was about the same as with hand-fired locomotives, but smoke was entirely absent unless this work was being done.

The time required to get the fire in condition so that it can be handled by the stoker before the beginning of the trip is practically the same as with the hand-fired locomotives. It is claimed that the control of the fire through the stoking mechanism is absolutely satisfactory. As showing the comparative work done in hooking and shaking the grates a record was kept which showed for one run that the hook was used for hand firing 13.8 times for the run. With the stoker a hook was used 14.2 times. The shaking of the grate with the hand-fired locomotives of the same class and for the same distance occurred eleven times and with the stoker thirteen times.

As to the coal consumption, no accurate figures have yet been determined to compare the performance with average firing.

The Barnum stoker, being experimented with on the Chicago, Burlington & Quincy, has not yet reached a state of development which would warrant its general application, and the committee was informed that on account of the increased demands for locomotive service the stoker was removed from the locomotives during the winter months. Further tests and experiments will be continued during the summer of 1910.

The Dodge, or Black stoker, which is under investigation by the Erie, developed several defects in design, the most important being the heating of the bearings of the distributing blades, which was so severe that lubrication was impossible, resulting in excessive wear. The blades were moved back to overcome this difficulty, but in the new position the effectiveness of the coal-spreading device was greatly impaired, thus necessitating further modification, the results from which are not available for this report.

The Hayden stoker, in operation on the Erie on five locomotives of a similar type to the one on which tests were made, is, apart from changes to improve effectiveness and reliability, the same as described in the committee's report of 1909. The changes, however, brought about material improvement, and indicate improved efficiency. On a trial test with a locomotive fired by hand and by the stoker, the equivalent evaporation per pound of combustible with the stoker showed a loss in comparison to hand firing of 1.22 on the trip East and .89 percent on the trip West. A comparison on the basis of combustible per ton-mile showed 14 percent less East and a saving of 5.15 percent on the West-bound test, while on a basis of combustible per draw-bar horsepower the stoker showed a loss of 5.6 percent East and 4.6 percent West. In view of the fact that identical tests will show a variation of this amount, it is taken that the stoker showing is at least hopeful.

The Street stoker, which has been in experimental service on the Lake Shore & Michigan Southern continually since May 1, 1909, is of the scatter type, in which coal is driven into the fire-box by steam jets. It consists essentially of three parts, namely, a crusher, an elevator and a distribution system. The crusher is located on the tender, a small section of the water-bottom being cut to accommodate it. It is of the swinging jaw type, and the opening is on a level with the tank blower, so that the coal can be scraped into it without being lifted. The coal, after being crushed, slides by gravity through a boiler-iron trough, pivoted to the tender into a hopper located beneath the deck plate of the locomotive, secured thereto and forming the lower end of the elevator casing.

The elevator consists of a double endless chain with drop-forged links having malleable iron buckets riveted thereon. This chain travels in a casing made of gas pipe of standard dimensions. The upper end of the casing is secured firmly to the boiler head, and the lower end to the deck plate. At the upper right-hand corner the elevator passes over a steel sprocket wheel which forms the drive. This wheel is driven through a worm by a small steam engine fastened to the boiler head. The coal is discharged from the elevator at a point on the boiler head directly above the fire-door. It falls through a distributing hopper into three distributors, one of which is located centrally and each of the other two on the side, and all above the fire-door. From these distributors it is spread over the grates. The distributors are made of cast iron, extending through tubes which are rolled and beaded into the back head of the boiler and the fire-box sheet. Each distributor is fitted with a steam nozzle through which a blast of steam is admitted intermittently for driving the coal into the fire-box. A discharge regulator is provided, which when moved to the right will give a heavy fire on the right side of the grate, and when moved to the left will give a heavy fire on the left side of the grate. The distributing hopper is provided with a deflector, by movement of which the major portion of the coal can be fed to the center or the side distributors as desired.

The claims made for this stoker are, first, its non-interference with the fire-door; second, the simplicity of its construction; third, the ease with which it is operated; fourth, the control it gives the fire; fifth, fuel economy. It is claimed that this stoker gives a much better control of the fire than is possible by hand firing. In regular service the steam pressure has been allowed to fall off from 40 to 30 pounds and restored to a maximum within two and one-half minutes, while the locomotive was working at full capacity with the injector on. The results of tests seem to indicate that the even distribution in thin layers of coal prevents the formation of clinkers. Under ordinary conditions the cleaning of the fire is not found necessary.

The Strouse stoker, mentioned in the report of the committee of 1909, is manufactured by the American Stoker Company, of Milwaukee, Wis., and is being experimented with on the Iowa Central, Minneapolis & St. Louis and Chicago & Alton. During the time of comparative tests on the Iowa Central the performance was very satisfactory. Experience has shown that the stoker is not mechanically perfect, and, therefore, it requires considerable skill and care on the part of the enginemen to avoid failure. The Stoker Company have made several improvements in the design of the machine in the past year, and, in view of the improvements that have been made, they have so materially improved its performance, that it is reasonable to assume that this machine will yet prove a successful device for automatic firing of locomotives.

It could hardly be expected that mechanical stokers at the present stage of development could show an economy over hand-firing by an expert fireman, but it is considered that if economy is expected it must be looked for in the comparison with the average of all grades of firemen in regular service. Designers of the present day are more interested in effecting practicability and security against failure rather than the promotion of efficiency by its use, as this effect is more or less taken for granted with any properly-designed and thoroughly practical stoker.

The main defect of the present stokers seems to be to a very great extent the coal-conveying apparatus, and it is the failure of this particular feature which usually makes the stokers of to-day seem unreliable.

The committee considered that the progress and the development of mechanical stokers during the past year is indicative of a determined effort to build stokers which will be in every way a success, and is convinced that the mechanical stoker is designed to be a very important feature in the operation of heavy locomotives in the not very distant future.

SELECTING A BOILER *

BY F. C. BITGOOD.

No more important duty ordinarily falls to the lot of an engineer than that of selecting apparatus for power plant equipment. To some this might seem to be a comparatively simple process, consisting merely in obtaining estimates from a number of concerns manufacturing different machines and appliances, and, on the basis of such figures, choosing what would appear to give the best returns for the amount of capital invested. In one sense, the principle is a correct one, but in striving to follow it out great difficulty is apt to be experienced in determining what really gives the best returns for the first cost. Many engineers or concerns, on receiving competitive bids, will write to parties who have used the various machines, and to whom they have been referred perhaps by the selling agent. In most cases replies will be received to the effect that the apparatus is all right and that the people are perfectly satisfied with it, so that in the end those making the selection have obtained but little assistance from outside parties regarding the question of one or another form being best suited to their particular purpose.

All the foregoing applies to the selection of boilers, and it is no wonder that those responsible for their purchase will at times resort to the easy expedient of accepting the lowest bidder. Again, in some cases guarantees are called for and the various competing concerns submit figures. Here, again, the customer is apt to be misled, for it is a well known fact that in boiler guarantees the most responsible companies submit, as a rule, the most conservative figures, so that as far as this feature goes the customer again receives but little help in making a selection.

This article will not deal specifically with the various boilers now on the market, but will present facts regarding different classes of boilers and point out what the author believes to be the best way of making a selection.

In the first place we must consider the class of service for which the boiler is to be used. If a contractor wishes to use a boiler for some temporary work it would be foolish to consider a very high class installation set in a permanent way, which would be of little value to him when he is through with the work. Again, there are cases where steam must be raised very quickly, starting with a cold boiler; this requirement would eliminate certain classes of boilers where the water capacity and construction is such that an attempt to raise steam from cold water in, say, half an hour, would surely lead to trouble on account of leakage, and what is more, would be impossible. For up-to-date power plants modern engineering practice has demonstrated that it is essential that the boilers shall be of the water-tube type in order to safely maintain the working pressures and to respond quickly to the varying demands for steam. Practice of to-day leads more and more toward driving the boilers at high capacities during the peak loads, and in the ability to withstand this sort of service the water-tube boiler is pre-eminent. Many shell boilers are still in use, and in some cases, such as temporary installations and the like, those of the portable type will evidently give better commercial returns than a high class installation set in brickwork. There is no set of conditions where a boiler is to be permanently located for power purposes, however, where any type of boiler will give as good results at the water-tube. In certain instances it is claimed that as the shell boilers, for example horizontal return tubular boilers, contain more water than water-tube boilers they will hold the steam better than water-tube boilers when there is a sudden demand upon them. This claim is often set up in connection with dye houses or other manufacturies where at certain times there is a much larger demand for steam than at others. Experience has demonstrated, however, that even for such service the water-tube boiler is superior on account of the fact that it responds so much more readily to being driven at an overload capacity.

With a properly arranged plant all that is necessary with water-tube boilers in case of a sudden demand for steam is to force them to a capacity to meet the demand, and by being able to do this the steam pressure may be maintained constant and the plant run along under uniform steam conditions. With shell boilers should there be a sudden demand for steam the pressure necessarily will fall and cannot be brought back as quickly as with water-tube boilers. In this connection it might be well to state that the water capacity in relation to the heating surface in a water-tube boiler is not as much less than in a shell boiler, as some engineers believe. In fact, manufacturers of horizontal return tubular boilers have claimed that their type of boiler is not handicapped in raising steam quickly through the amount of contained water, because with their horizontal return tubular boilers the water content is no more, compared with the heating surface, than in some forms of water-tube boilers. Perhaps a fair estimate would be that the average large water-tube boiler contains about one-fifth less water as compared with its heating surface than a horizontal return tubular boiler.

To illustrate the difference in the time required to get up steam with various boilers, it might be stated that steam can be raised from cold water in Babcock & Wilcox water-tube boilers to 200 pounds pressure in one-half hour. In fact, in a test where a forced blast was available steam has been raised to 200 pounds in 12½ minutes after lighting the fire, starting with water at about 70° F. With internally fired boilers the shortest time allowed in the United States Government service for firing up Scotch marine boilers is six hours, and the time usually taken about 12 hours. In large double-ended Scotch boilers used in transatlantic service the fires are usually started 24 hours before the time of getting under way. The long time taken to raise steam in these boilers is necessary in order to make sure that there shall be no undue strain due to unequal expansion in different parts of the boiler.

There are, of course, other requirements for a good boiler than those which we have mentioned. Primarily the boiler must be safe, and in addition to this it must be of a form that can be readily cleaned. In respect to safety a water-tube boiler so designed that the hot gases do not impinge on the steam and water drums is eminently safer than boilers in which large masses of steam and water may be liberated by the failure of a portion of the heating surface through excessive heat caused by a deposit on the inside of the boiler. Any boiler is a magazine of stored energy, and there may be accidents through tube failures, but a tube failure cannot lead to as disastrous results as the rupture of a shell of large diameter which may set free suddenly the entire energy contained within the boiler. A well built water-tube boiler is essentially a "safety" boiler, and this fact is well appreciated by engineers. The metal of a boiler which is exposed to the most intense heat cannot be over a certain thickness because

* From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers, Cincinnati, May, 1910.

of danger of overheating. This fact eliminates many boilers of the shell type for purposes where a high steam pressure must be carried.

Few people appreciate how much the economy of a boiler is affected through the accumulation of dust or soot on the tubes. This holds for a vertical tube boiler as well as for one with inclined tubes. In some recent tests it was clearly demonstrated that when a vertical tube boiler was dusted first in the way ordinarily done at the plant and later in a thorough way, the difference in the flue gas temperature when running slightly above rating was over 100° Fahr. If there are any parts of the surface which are inaccessible to the steam or air lance used for dusting, the economy may fall off very greatly on this account.

All interior parts of a boiler should also be accessible for cleaning. This is especially so where the feed water contains incrusting solids. The falling off in economy through a thin coating of scale, inside the boiler is not very big, but the presence of such scale, especially if some of it becomes detached, will cause difficulty through blistering the tubes. The only practical way of handling a feed water where there are incrusting solids is to clean the boilers at as frequent intervals as are found to be necessary.

Another feature which is often brought up for consideration in selecting a boiler is whether a superheater should be used. There is no easier way of obtaining fuel economy in a power plant than by the introduction of a reasonable degree of superheat. Practice has demonstrated that with properly designed superheaters and pipe fittings there are no more operating difficulties in a superheating plant than in a saturated steam plant.

It is a fair estimate to say that with 100° of superheat a coal saving of about 10 percent will result in the average power plant.

The most rational way of selecting a boiler is to find out what boilers are successfully used for the class of work under consideration, and if engineering practice quite universally has adopted one or another style of boiler, it is usually safe for the purchaser to adopt this style. Having selected the general type, or having settled on one particular type, the next step would be to purchase at as satisfactory terms as possible. Again, if boilers of a certain class have been used with eminent satisfaction in a plant and it is desired to make an extension, the fact that the operating crew are satisfied and well acquainted with the operation of the boilers already at the plant, should be given due consideration. By following this plan the purchaser is safeguarded, but there always will be new boilers placed on the market for which great claims will be made, and which may perhaps be purchased at a lower price than other boilers which have been tried out and shown to give reliable results. If one of this class of boilers is purchased it might, on the one hand, turn out to be a good investment, but on the other hand it might not. It is a fact that all of the best builders have found it necessary to considerably modify the design of their boiler, after having first placed same on the market, in order to eliminate certain defects which can only be found after long periods of actual service.

The mere fact that the majority of boilers placed on the market have eventually disappeared, whereas others that were largely used before the new designs were brought out, are still used and continue in favor, shows that there must be some inherent advantages in the well-tried and older forms. To sum up the situation the purchaser cannot go far astray by selecting a boiler which has given satisfaction in years of service for the particular class of work at hand, whereas should he purchase a comparatively untried boiler he may have to pay for his experience and be disappointed.

There is a feature which often makes it desirable to purchase a boiler from a well known and reliable company, which is that the value of the plant, should the property ever be offered for sale, is enhanced thereby over what it would be should the equipment be of a comparatively unknown type. The author does not wish to take the position that there is no field for a new boiler. Far from this; we are in an advancing age and improvements naturally follow one another. Before selecting a new type of boiler, however, the highest expert advice should be sought in order to guard against disappointment, and anything which will make steam should not be considered as a good enough boiler to warrant the purchaser in being governed by the price alone. In a recent meeting a practical engineer said that he believed that stringent rules for safety were not required, as any boiler he had ever seen would withstand much more pressure than it was ever designed for, and he went on to say that an ordinary tomato can would withstand about 100 pounds pressure. There are still engineers who believe that "any old thing" will do in the way of a boiler, and it is this feeling that those dealing with the higher classes of apparatus often have to contend with. Make sure you have a safe boiler, make sure that it has already given good satisfaction in long service and that it is recognized among engineers as a standard. If you wish to take chances by using a comparatively new boiler, call in the highest expert skill if an expert is not available in your organization, but do not assume that the problem is a simple commercial one where the lowest bidder or the one *guaranteeing* the best *efficiency* should be awarded the contract.

The Kewanee Boiler Company's Improvements.

Five new buildings of the improved type of factory construction, to cover more than two acres, are to be added to the plant of the Kewanee Boiler Company, Kewanee, Ill., on the ground recently acquired north of the present works of the company. Plans for these buildings are now assuming definite form and work has been started and will be rushed to completion as rapidly as possible. Contracts have already been awarded on some of buildings. The new buildings to be erected are as follows: Addition to boiler shop; new foundry and machine shop; radiator machine shop; radiator cleaning room; large storage room.

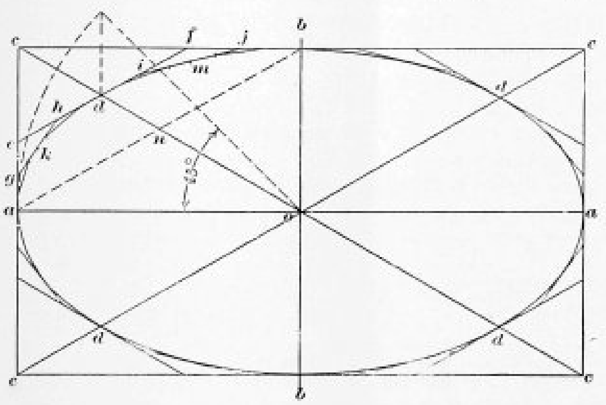
The addition to the boiler shop will be 122 by 128 feet, with a bay on each side. It will be of steel construction, with brick walls built a few feet up from the ground; the remainder of the wall being of glass, set in steel frames, to obtain the greatest possible amount of light. In this new addition will be a riveting tower 36 by 60 feet, all steel, in which a new riveter is to be installed, together with many other devices and tools which will facilitate operations. An important change in the present boiler shop will also be made in connection with the construction of this addition. About 200 feet of the roof of the present shop is to be raised 12 feet. This change is to be made for the purpose of giving more room for the cranes. Two 60-foot and one 38-foot crane will be added.

The foundry and machine shop will be built in the northwest corner of the grounds and will be 80 by 480 feet in size. It will be constructed along the same general lines as the boiler shop, and will be arranged with a 40-foot crane. The pattern shop and storage room for patterns will also be in this building. At the north end of the present radiator shop will be a cleaning building 130 by 160 feet, which will be used as the radiator machine shop. A radiator cleaning room, 80 by 80 feet, and a storage room, 40 by 120 feet, will also be erected.

The machinery to be installed in these buildings will be operated by electricity. It is estimated that the improvements will give the plant an additional capacity of 25 percent. Another radiator molding machine is being built by the company, which will also increase the radiation output. The number of additional employees that will be required will depend largely on general business conditions. It is estimated that the total cost of this work will be, approximately, $200,000.

Simple Method of Drawing an Ellipse.

In the Feb. 24 issue of the *Engineering News*, Mr. G. W. Colles gives a method for drawing ellipses which is very simple and convenient, and which, therefore, will undoubtedly be of interest to draftsmen and designers in general. Most methods only give points upon the curve, ignoring the fact that the *direction* of the curve at the point is fully as important as the point itself. The present method is based on the fact that every ellipse may be considered a strained circle; that is, one which is distorted in one or two directions proportionately at



SIMPLE METHOD OF DRAWING AN ELLIPSE.

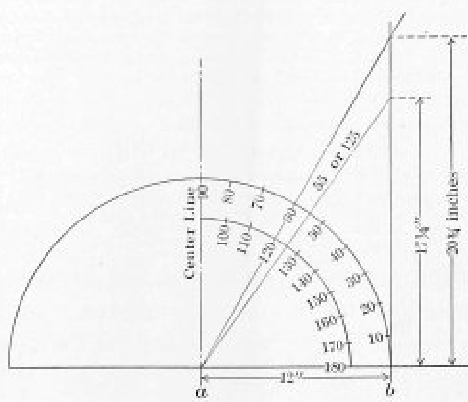
all points. The accompanying illustration shows the method applied. Lines *aoa* and *bob* are the axes, intersecting at *o*. Upon these construct the rectangle *cccc* within which the ellipse is to be inscribed. Draw the diagonals *cc*. Draw *ox* at 45 degrees to axis *aa*, making it equal to *ao*, and drop a line *xd* perpendicular to the axis *aoa*, intersecting *oc* at *d*, which is a point upon the ellipse, and the tangent *cdf* is drawn parallel to *coc*. In small ellipses, the three points and tangent on each quadrant will be sufficient to enable the ellipse to be constructed satisfactorily, but for greater exactness bisect *ac* and *cd* at *g* and *h*, and *df* and *fb* at *i* and *j*; then the lines *gh* and *ij* will be tangent to the ellipse, and will practically draw the curve, but if this is still insufficient we may bisect *gh* at *k* and *ij* at *m*, and again bisect *ag*, *gk*, *kh*, *hd*, *di*, *im*, *mj* and *jb*, joining the points of bisection to give further tangents to the curve.—*Machinery*.

Self-Dumping Ash-Pans.

The subject of self-dumping ash-pans was one of the topics of discussion at the recent convention of Railway Master Mechanics. H. T. Bentley, of the C. & N. W., stated that after careful consideration of practically every self-dumping pan in use, they decided to adopt as a standard a pan equipped with a bottom-slide apparatus. Although every contingency was provided for, as far as possible, in the design, the results were disappointing, as the pans warped and got out of shape, so that live cinders would drop, starting fires and causing other trouble. Also during cold weather the slides would freeze solid, notwithstanding the fact that a heater was attached to each one to overcome this difficulty. Mr. J. F. De Voy, of the C., M. & St. P., stated that after experimenting with all the ash-doors they obtained the most successful results from the door-operating mechanism used by the Chicago, Burlington & Quincy, as this is the only ash-pan among a dozen which they have used with which they have had absolutely no trouble. J. A. Talty, one of the inspectors for the Public Service Commission of the State of New York, called attention to the many little defects for which a remedy should be applied to decrease the amount of fire scattered along the right of way. These remedies included such things as providing fastenings to hold the slides closed, patching holes so that the cinders cannot fall out, etc. He favored the use of cast iron ash-pans rather than steel.

A Home-Made Protractor and Convenient Method of Getting Offsets for Angles.

The writer recently had a number of bends and angles to make in elbows, branch pipes and such work. To aid in getting this work out I took a piece of sheet iron which was large enough to contain a quarter circle with a 12-inch radius. I divided the quarter circle into nine equal spaces, counting each space 10 degrees, and erected a perpendicular line at the point *a*, and then with a straight edge resting on



HOME-MADE PROTRACTOR.

the point *a* draw lines through the degree points and cutting a line drawn upright to the base line at the point *b*. By measuring the points where these lines intersected the upright line at *b*, the height of the offset is found and can be conveniently noted in a memorandum book where it is at hand whenever needed in the layout work. As shown in the sketch the 60-degree angle has an offset of 20¾ inches in 12 inches, and the 55-degree, or 125-degree angle, has an offset of 17¼ inches in 12 inches.

JOHN COOK.

At the Mare Island Navy Yard substantial reductions in the cost of work have been accomplished by introducing more efficient methods of management. In the boiler shop, due to the introduction of such improved methods, a remarkable record was made in the cost of retubing three watertube boilers of the small tube type. The total time taken previously to retube three boilers in the shop was from eighty to ninety days, and the direct cost was about $1,100 per boiler. The time taken under the changed conditions was fifteen days, and the direct cost was a little over $400 per boiler.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Indexing Tracings, Blue Prints and Patterns.

On another page we are publishing an article which describes a convenient method of indexing and filing tracings. Subsequent articles by the same author will deal with blue prints as returned from the shop and shop patterns. These articles are of interest not merely because they describe a certain method of caring for tracings, blue prints and patterns, but more particularly because they call attention to the advantage of systematizing the minor details of shop management.

In this case a slight expenditure of time and money greatly facilitated the work by simply providing a place for everything and the means of readily finding it. Other systems of indexing and filing are undoubtedly in use which, perhaps, are just as good, and, possibly, better than the one described in this article, but the author states that this method has proved useful as meeting conditions in a modern, up-to-date shop, where a variety of work is done. The system, therefore, is at least worthy of careful investigation, and possibly of a trial in shops where no such system is now in force. Changes and modifications to suit special requirements could easily be made, and, perhaps, further advantages gained thereby. Careful and businesslike attention to details such as these deserves commendation, and usually results in a saving of dollars and cents.

Heat Treatment of Steel.

Recently we called attention to the importance of making a careful study of the behavior of boiler steel when subjected to heat as in the processes of welding, flanging, etc. In this issue we publish an article which goes into this subject with considerable detail, and brings out many metallurgical points which, although well known to steel makers, are probably not fully appreciated by the majority of boiler makers. The effect of heat upon the structure of steel must be fully understood if the steel is to be left in the best possible condition for enduring tensile and bending stresses when finished. There are few parts of a boiler which are not affected by either mechanical or heat treatment during the process of construction of the boiler, and if the effect of either the heat or the mechanical treatment, or the combined effect of both, is not understood, certain parts of the boiler may be finished in a condition wholly unsuited for their purpose, whereas if a little thought and care, and the proper treatment, had been given the steel, the full strength of the metal could have been secured, and the possibility of failure eliminated. The heat treatment of steel should, therefore, be given as careful attention as the mechanical treatment now is.

Mechanical Stokers for Locomotives.

The progress of the development of mechanical stokers for locomotives is well set forth in a report presented at the recent convention of master mechanics. That the development has been slow is to be expected in view of the difficulties to be overcome, but enough has now been done to show that in future heavy power can be taken care of by automatic firing. The economy of the mechanical stoker is still in doubt, but, after the more serious obstacle of perfecting a practical and durable machine has been overcome, the economy can probably be easily improved. The use of the mechanical stoker for stationary and marine boilers has always resulted in increased economy, due to better combustion, and there is no reason to suppose that the same result cannot be obtained on a locomotive. It should not be expected that a mechanical stoker will do better work than can be done by an expert fireman, but there are very few railroads which are able to man all their locomotives with expert firemen, and consequently the average economy with hand firing is probably not very much better than can be obtained even now with the mechanical stoker. Stokers can now be depended upon to handle the heaviest loads, maintain a steady steam pressure, and, at the same time, they can be designed so as to admit of easy regulation, and they can be used either alone or in conjunction with hand firing. The greatest difficulty just at present seems to be that the coal-conveying devices which have so far been used for this purpose cannot be called entirely satisfactory. This problem, however, is one which will be solved by experience, as a greater number of locomotives are equipped with stokers. The advantages of a mechanical stoker have frequently been enumerated in these pages, and it is hardly necessary to take them up again. It is sufficient to realize that the automatic stoker will soon be a necessity on both heavy freight and fast passenger service.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—I understand that a new law regulating the installation of steam boilers came into force in Germany this year. Can you tell me what the principal features of this law are? HAMBURG.

A.—According to the new German boiler law, which came into effect Jan. 1, boilers are divided into two classes—land and marine. No cast iron or malleable cast iron may be used in any part of the boiler walls in boilers which are intended for a working pressure of over 150 pounds, and brass is never to be used for firetubes of not more than 3.15 inches outside diameter. There must not only be two feeding devices for the boiler, each having independent operative mechanism, but each must be of such a size that it shall be capable of feeding the boiler with double the quantity of water normally required. In the case of steam-driven feed pumps, driven direct by the main steam engine, one and one-half times the normal evaporating capacity will suffice. One of the stipulated feed devices may be replaced by the direct use of a water pipe, if it be guaranteed that the actual pressure of water service at the boiler is always at least two atmospheres more than the steam pressure permitted in the boiler. The lowest permissible water level hitherto shown by a clearly visible mark must now be marked with the inscription "Niedrigster Wasserstand." Fixed and portable boilers must be fitted with at least one and two safety valves, respectively, spring lever and weight valves being permitted. In the latter case, the pressure exerted on each valve must not exceed 1,323 pounds.

Q.—What is a quick method for determining the minimum heating surface of a locomotive boiler? J. RYAN.

A.—A preliminary determination of the total heating surface in square feet of the boiler for a simple locomotive engine can be made by multiplying the area of one cylinder in square inches by 3.75.

Q.—How does the cost of maintenance of various types of boilers compare? R. H. HOUSE.

A.—The cost of maintenance of boilers is a very variable quantity, depending not only upon the type of the boiler, but also upon the quality of materials and workmanship used in its construction, and also upon the conditions under which it is worked. Assuming, however, good materials and workmanship, and reasonable care in operation, the following figures give some idea of the annual cost of maintaining the boiler and its fittings in good working order expressed on a percentage of their original total cost:

Internally-fired stationary multi-tubular boilers and fittings, 4 percent.

Brick work setting and fire bridges of internally-fired, stationary, multi-tubular boilers, 2 percent.

Externally-fired stationary, multi-tubular boilers and fittings, 4 percent.

Brick work setting and fire bridges and externally-fired stationary multi-tubular boilers, 3 percent.

Portable boilers of the locomotive type and fittings, 6 percent.

Vertical tubular boilers and fittings, 7 percent.

Marine return-tube boilers and fittings, 5 percent.

Watertube stationary boilers with tubes of from 3 to 4 inches diameter, including fittings, 5 percent.

Brick work setting of watertube stationary boilers, having tubes from 3 to 4 inches diameter, 3 percent.

Watertube stationary boilers, with tubes of from 1 to 2 inches diameter, including fittings, 6 percent.

Brick work setting of watertube stationary boilers, having tubes 1 to 2 inches diameter, 3 percent.

Watertube marine boilers, having tubes from 3 to 4 inches diameter, including fittings and casings, 5 percent.

Watertube marine boilers, having tubes from 1 to 2 inches diameter, including fittings and casings, 6 percent.

Locomotive boilers and fittings, 7 percent.

Q.—What is the safe working stress which can be allowed on the bolts of the flanges of steam pipes? EVAPORATE.

A.—Bolts which are used in the flanges of steam pipes are severely stressed in tightening them sufficiently to secure steam-tight joints. It is, therefore, necessary to use a factor of safety high enough to provide for both the stress produced by tightening up the nuts and the load due to the pressure of the steam. In general, iron bolts may be loaded to 2,500 pounds per square inch and mild steel bolts may be loaded to 3,000 pounds per square inch. The sectional area in each case should be taken at the bottom of the thread. For the standard pro portions of bolts for various sized flanges see pages 179, 180 and 181 of the June, 1910, issue of THE BOILER MAKER.

Q.—Boiler explosions are frequently attributed to the fact that the water is allowed to become low in the boiler, causing the fire sheets to become overheated, so that when cold water is admitted to the boiler the hot plates cause an excessive generation of steam, causing overpressure and the explosion of the boiler. How is it possible for such an excess of pressure to be generated when only a comparatively small part of the heating surface is at a red heat? TECHNICAL.

A.—The theory to which you have referred is somewhat obscure, and we doubt if anyone can say positively just what action takes place. The effect of cold feed water on overheated plates is undoubtedly greatly exaggerated, as far as rapid generation of steam and excessive pressure are concerned. The danger in such a situation very probably lies in the fact that admitting cold water to the hot plate causes immediate contraction of the plate and injury to the metal, so that the plate fractures. A number of experiments have been carried out to show that when cold feed water is admitted in this way to overheated plates there is no danger of explosion of the boiler from the sudden generation of steam.

In one experiment steam was raised to 150 pounds pressure in a boiler, the water was blown off, and the plates were permitted to become nearly red-hot. Water was then pumped into the boiler, but there was no sudden generation of steam, the water simply cooled the plates, and the boiler did not explode. In another experiment, the water was blown off until the crown of the furnace was exposed and became red-hot. Water was then admitted into the boiler, which resulted in cooling the plates and causing the joints to leak badly, but no explosion took place.

As a matter of fact, even after the metal becomes red-hot, the total amount of heat which it contains is not sufficient to generate much steam, and therefore it could not by any possibility cause excess of pressure. The danger lies in the liability to injury of the plates, due to excessive and unequal strains, caused by the sudden contraction of the steel after excessive expansion.

COMMUNICATION.

Regarding the Wood Fire-Box.

EDITOR THE BOILER MAKER:

While in attendance at the Master Boiler Makers' Convention, in Niagara Falls, in behalf of the William H. Wood Fire Box & Tube Plate Company, I failed to hear Mr. Linderman speak of the stay-bolt trouble in the Wood fire-boxes on the

New York Central. If Mr. Linderman made those remarks I surely think he was mistaken, for I have watched the boilers daily ever since they were in service, and I can contradict the statement made by Mr. Linderman as an error, as I have watched the boilers daily, and surely should know better than Mr. Linderman as to the stay-bolts leaking. I am very sorry that Mr. Linderman should have committed such a grave error, and especially at such an important time, as it is calculated to mislead, for it is really the contrary, as our boilers cause little or no trouble with leaky stays, and there were no broken stay-bolts. There were four or five fractures, as published in my sworn report. FRED. H. SNELL.

Buffalo, N. Y.

STAFF'S DREAM.*

A sort of serio-comedy, in two parts—top and bottom (water on the side).

MOULD, BEFORE AND AFTER POURING.

Staff.......................................B. E. D. Stafford
The Comet...Halley
Jim......................................Nat Tube Goodwin
Youngster.............................Dave Champion's Son

First and Second-Story Men, Listeners, Butters-In, Reminiscencers, Jokers—real and thought-so's.

Time: Foremen Boiler Makers' Convention.

Place: Niagara Falls.

ACT I.

A room below stairs; tables; chairs; numerous bottles, etc. (principally etc.); the full company.

Jim: Well, Staff, it's up to you. We're all in.

Staff: Boys, I'm going to tell you a dream I had last night: I went to bed rather late and had just dropped off to sleep when the telephone bell rang. I didn't think it was time for the morning call, so I jumped out of bed and grabbed the receiver.

"Well?"

"Is this you, Staff?"

"Yes; who is it?"

"Why, this is Halley!"

"Halley? Hell-oh! Halley who?"

"Why, Halley, the comet man!"

"Oh, is that you, Halley? How are you? What brings you around?"

"I understand the boiler foremen are having a convention. Know anything about it? Thought I'd come if there is a good crowd."

"Yes, there is a convention, and the crowd is all right; but what has that got to do with you, Halley?"

"Well, I'm something of a boiler maker myself."

"A boiler maker? What have you ever done for the boiler makers, Halley?"

"Why, don't you remember, I fixed up the first locomotives about seventy-five years ago—the last time I was here."

"No, Halley, you can't prove it by me; but if you did, you fixed the locomotives all right, so as to keep the boiler makers busy. But what are you going to do for them this time, Halley?"

"Why, Staff, you ought to know. I've done it already."

"Put me next."

"Haven't I given them the Tate flexible stay-bolt so as to make it easy for 'em?"

"I'm on, Halley; I'm on. You're all right, and I know it. But say, what do you want to haul a fellow out of bed for? Oh! excuse me, Halley, you're another night owl. I see."

"No, Staff, I've got a message I want you to give the boys. I've been holding back this comet to show it for the first time at this convention. I know a lot of the boys will be sitting up, and I will show it for the first time over Niagara Falls to-morrow night. Get busy. Goodby."

Youngster (as he bounds into the room as Staff finishes his story). Halley's comet! The comet is in sight! Come, quick! Come up on the roof! The comet is right over Niagara Falls!

ACT II.

Scene: Partly 60,000,000 miles away and partly on the roof, which only seems so (the elevator is not running).

First and Second-Story Men, Listeners, Butters-In, Reminiscencers and Jokers. They at first hesitate, and then have followed the youngster to the roof. The comet appears R. U. E. in all the glory of a safety match.

Problem: Did the boy lie, or what kind of glasses did the observers use?

* From the "Railway Age Gazette."

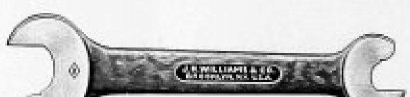
PERSONAL.

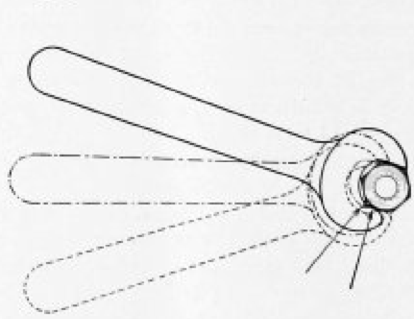
WILLIAM L. AUSTIN has been elected president of the Baldwin Locomotive Works, Philadelphia, Pa., succeeding the late John H. Converse. Mr. Austin was one of the vice-presidents of the company, as well as a director, and was a member of the firm of Burnham, Williams & Company before its incorporation as the Baldwin Locomotive Works. He has been associated with the concern for many years, for a number of which he has been at the head of the drafting department.

ENGINEERING SPECIALTIES.

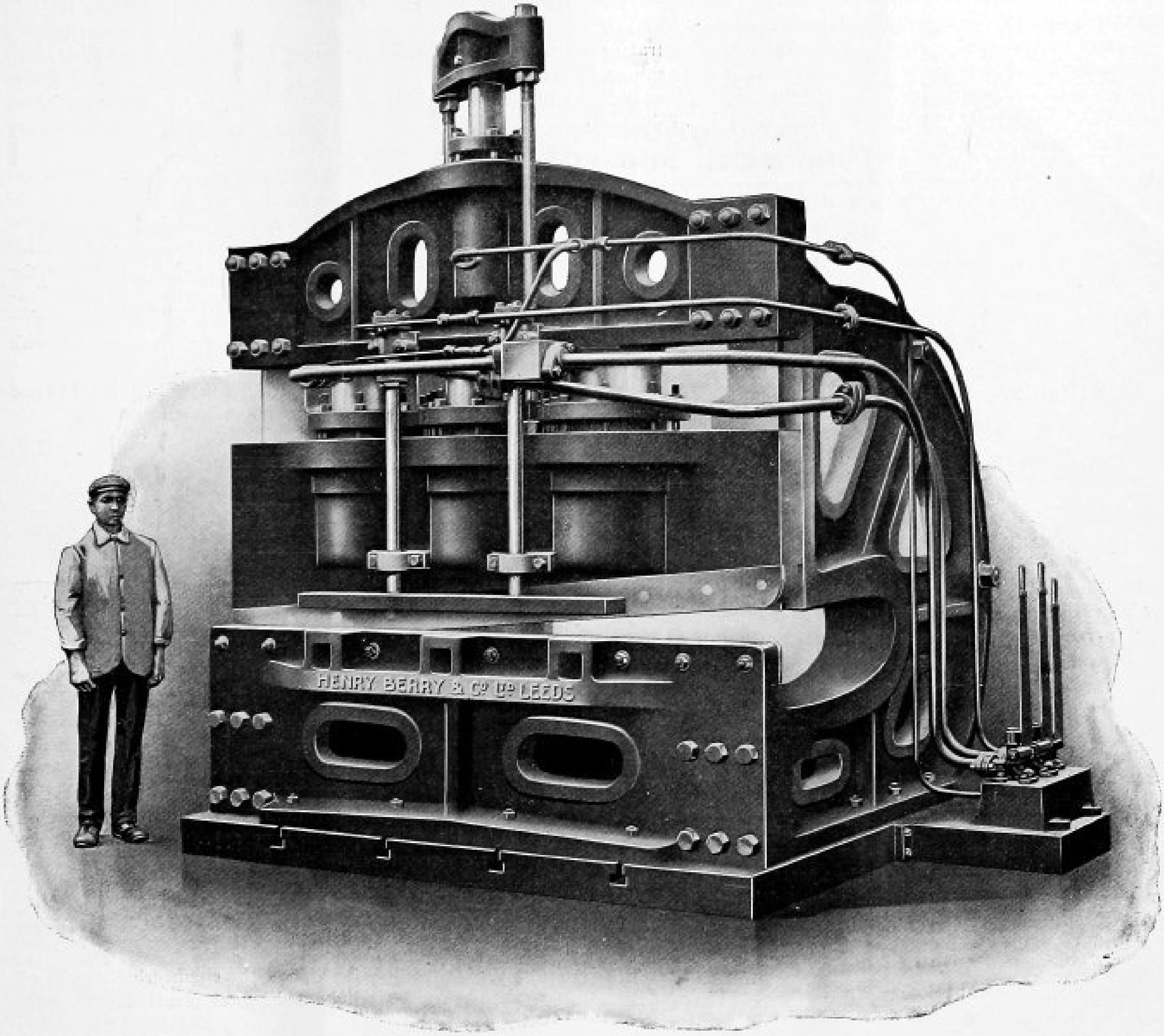
Williams Rachet Wrench.

J. H. Williams & Company, Brooklyn, N. Y., have just placed on the market a new drop-forged wrench, which is practically a ratchet wrench without any ratchet mechanism. It is claimed that it will do anything that any other drop-forged wrench can do, and do it with imperceptible wear on the nut or tool. The principle involved in moving any nut, set screw, etc., with a wrench is two points of contact. The designer of this wrench





appreciated this fact, and cut out the useless end of the ordinary wrench, producing a tool with a reciprocating action which promises to revolutionize the use of drop-forged wrenches. It is not necessary to lift the tool from each side of the nut, as is done with an ordinary wrench, but the action is progressive and rapid, making the tool a timesaver. No pawl or other mechanism is necessary since turning over the tool enables either right or left-hand adjustment of the nut.



Large Hydraulic Plate Shears.

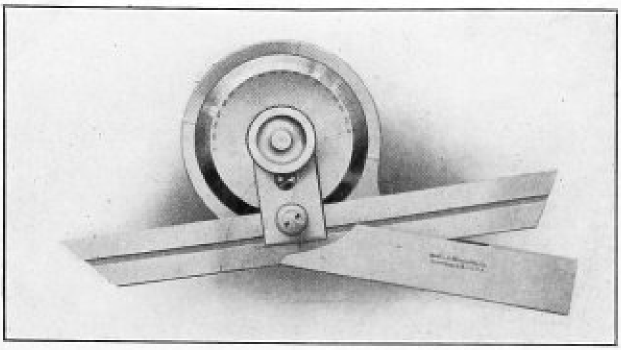
The illustration shows a hydraulic plate shear for cutting hard steel plates, two of which were recently supplied to the Italian government by Messrs. Henry Berry & Company, Ltd., Leeds, for use in the dockyards. The machine has all the framing of cast steel, and is mounted on a massive cast iron baseplate; it will cross-cut hard steel plates up to 6 feet 7 inches wide by 1¼ inches thick and of any length. There are three main cylinders, each fitted with turned and polished rams, so arranged that one, two or three rams may be used as desired, thus ensuring considerable economy in the use of pressure water when shearing thin plates. The main slide is of cast steel, carrying the moving shear blade, and is guided by carefully machined and fitted slides on the side frame. The latter are bolted to the baseplate and held rigidly in position by the front shear frame, the crosshead and heavy stays at the rear of the machine. A drawback cylinder, cast in the crosshead, is fitted with a turned and polished ram working through a gunmetal gland with leather packing, which lifts up the shearing slide after making a cut; and two small vice rams are placed at the front of this slide to hold down the plate being sheared.

All of the rams for the different movements are controlled by one man from a set of working valves of Berry's Patent B. B. type, which are carried on a stand in a convenient position.

The machines are to work with an accumulator pressure of 1,500 pounds per square inch, and the first one was recently tested at the makers' works in the presence of an inspector for the Italian government by shearing plates 6 feet 7 inches long by 1½ inches thick.

Improved Bevel Protractor.

The improved bevel protractor shown herewith, which was recently put on the market by the Brown & Sharpe Manufacturing Company, Providence, R. I., is an accurate and inexpensive tool for laying out or establishing angles. Not only is it useful to draftsmen but it is also of great service to mechanics. In design the tool is very simple, and is very similar to the improved universal bevel protractor made by the same company. The main point of difference between the two tools is the fact that there is no vernier on the bevel protractor, and so the measurements cannot be made to such a degree of fineness. To facilitate use of the tool one side of the protractor is flat, and this allows the tool to be laid flat on the paper or work, a decided advantage that users of the protractor will appreciate. The dial is graduated in degrees, and these graduations extend over an arc of 180 degrees, reading from zero to 90 degrees from each extremity of the arc. Especial care is taken with these graduations to have them accurate. The large central stud upon which the dial of the protractor turns is hardened in order to eliminate as much wear as possible. When the protractor is set and the nut tightened it clamps the dial rigidly in position so that there is no danger of slip. The blade of the protractor is free to move backward



and forward for its entire length independently of the dial, and this adapts it unusually well for work where other protractors cannot be used. It is clamped independently of the dial and is rigidly held in place. Great care has been taken in cutting the grooves, etc., so that there is very little chance for dust to accumulate and cause inaccuracies in the measurements.

Keuffel & Esser Duplex Slide Rule.

An improved form of patented duplex slide rule has been recently placed on the market by the Keuffel & Esser Company, 127 Fulton street, New York. The most recent improvement is the L-shaped end plate, which enables any desired adjustment of the slide to be secured by loosening a screw which passes through the upper portion of one plate, is threaded into the other and fits an elongated hole in the outer section of the slide rule. Loosening the screws at each end of the rule permits the movement of this outer section either in or out to give any desired friction on the slide without disturbing the longitudinal relation of the scales.

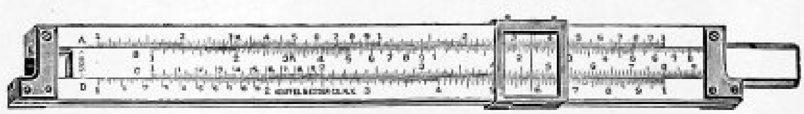


FIG. 1.—FRONT VIEW OF NEW ADJUSTABLE DUPLEX SLIDE RULE.

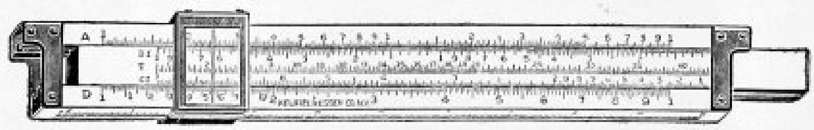


FIG. 2.—BACK VIEW OF THE RULE, SHOWING THE INVERTED SCALES.

The duplex slide rule is so named because it is graduated on both faces, thus giving practically two rules in one. It is formed of three parts, the two outside pieces constituting the body of the rule and the other the slide. The slide being the same thickness as the rule the surfaces of both are flush, and all the graduations are on the exterior, where they may be readily seen and utilized by simply turning the rule over.

The front face of the duplex slide rule, Fig. 1, is graduated like the familiar Mannheim rule, with all four scales progressing from left to right, while the reverse face, shown in Fig. 2, has the *A* and *D* scales graduated in the customary way, while the *B* and *C* scales are inverted and progress from right to left. The slide in addition to the two inverted scales has the scale of tangents usually found on the back of the slide of an ordinary rule. The indices of the scales on one face are in alinement with those on the other face, and a runner encircling the whole rule enables coinciding points on any scales of either face to be found at once.

The principal advantage of the inverted scales lies in the reduction of the operations required to perform many problems, with a consequent saving in time and increase in accuracy. This is because when setting to quantities on the inverted scales the reciprocals of these values, with respect to the regular scales, are given. Thus the operations of multiplication and division are reversed, and what is a dividing operation with the regular scales becomes a multiplying process with the inverted ones.

These patented duplex slide rules are made in 5, 8, 10, 16 and 20-inch lengths, with and without trigonometrical scales.

TECHNICAL PUBLICATIONS.

Corrosion and Preservation of Iron and Steel. By Allerton S. Cushman and Henry A. Gardner. Size, 6 by 9 inches. Pages, 373. Figures, 68. New York, 1910: McGraw-Hill Book Company. Price, $4 net.

This book was written mainly to elucidate the electrolytic theory of corrosion and a considerable portion of it is taken up with the description of results of the researches of one of the authors who has been working in a government laboratory along these lines. The book is not limited to this, however, as the authors have endeavored to include or mention the results of all recent investigations of original researches touching on the subject which have appeared up to the time the book went to press.

Electric Power Plants. By Thomas Edward Murray. Size, 6 by 9¼ inches. Pages, 337. Figures, 152. New York, 1910: The New York Edison Company.

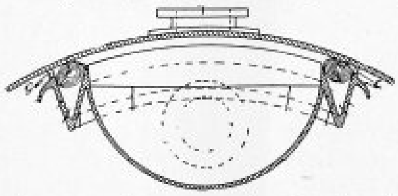
This book is designed to exhibit the engineering details of certain modern electric light and power plants which represent the most advanced design and construction. They comprise the largest stations of the New York Edison Company in the Borough of Manhattan, the new power stations of the Brooklyn Rapid Transit Company, the Gold Street Station of the Kings County Electric Light & Power Company, two stations in smaller cities, one industrial power plant and one hydro-electric plant. The author was the designer of these plants, supervised their construction, and, in the book, he has confined himself to the exposition of facts and of data valuable for the purposes of comparison to the electrical engineer and power station builder.

SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

952,831. MEANS FOR SEPARATING WATER FROM STEAM IN STEAM-BOILERS. DAVID MILLS AND ARCHIBALD JOHN IRVINE, OF JOHANNESBURG, TRANSVAAL.

Claim 1.—In means for separating water from steam in steam boilers a vessel located in the steam space of the boiler and constructed to form a chamber or space around its upper edge, wire gauze arranged in said space through which the steam must pass in its passage into



the vessel on its way to the steam outlet, the walls of said chamber serving as re-evaporating surfaces for the separated water, and passages formed in the upper edges of the vessel around the gauze. Five claims.

952,833. AUTOMATIC-SHUT-OFF WATER-GLASS. CLEMENT FRANCIS MOORE, OF CHICAGO, ILLINOIS.

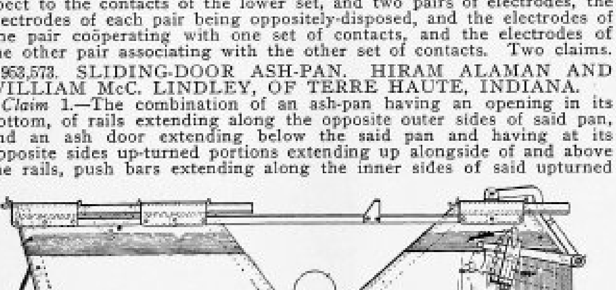
Claim 1.—The combination with a water glass, of valves at its ends, respectively, springs alined in the tube and normally holding said valves open, and means whereby the elastic force of the springs presses them out of alinement, allowing the valves to shut, when the glass is broken. Five claims.

952,909. WATER-GAGE. JULIUS TOROK, OF RENOVO, PENNSYLVANIA.

Claim 1.—In a water gage, a casing, a housing mounted thereon and communicating therewith, a water pipe communicating with said casing, a water pipe communicating with said housing, guide rods carried by the housing and depending into said casing, a float slidably-mounted upon said rods and provided with a vertically-disposed support, an upper and a lower set of resilient contacts secured to said support, the contacts of the upper set disposed at right angles with respect to the contacts of the lower set, and two pairs of electrodes, the electrodes of each pair being oppositely-disposed, and the electrodes of one pair coöperating with one set of contacts, and the electrodes of the other pair associating with the other set of contacts. Two claims.

953,573. SLIDING-DOOR ASH-PAN. HIRAM ALAMAN AND WILLIAM McC. LINDLEY, OF TERRE HAUTE, INDIANA.

Claim 1.—The combination of an ash-pan having an opening in its bottom, of rails extending along the opposite outer sides of said pan, and an ash door extending below the said pan and having at its opposite sides up-turned portions extending up alongside of and above the rails, push bars extending along the inner sides of said upturned



portions of the door and secured thereto, rollers running on the rails and means supporting said rollers from the upturned portions of the door, the push bars extending between the rollers and the upturned portion of the door and spacing the rollers away from the upturned portions of the door whereby the rollers are set to a position relatively near the side of the ash-pan. Two claims.

953,212. MEANS FOR CONTROLLING FUEL-SUPPLY IN STEAM-GENERATING SYSTEMS. HERMANN LEMP, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

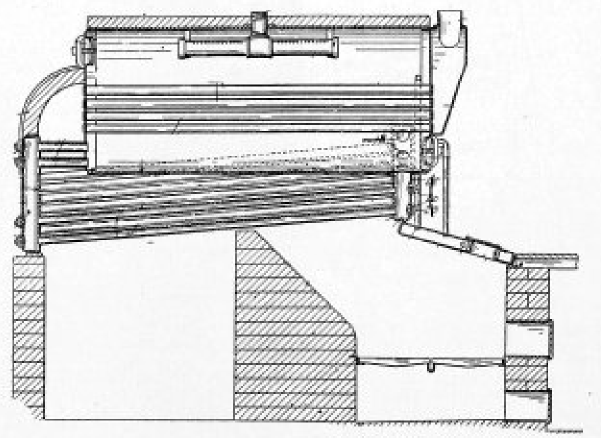
Claim 1.—The combination of a steam generator, a combustion chamber, an engine, a steam conduit between the generator and the engine having a trottle valve therein which delivers a continuous supply of steam at different pressures to the portion of the conduit between it and the engine, a fuel atomizing device, a source of fuel for supplying the device, a steam supply pipe for the atomizing device leading from said conduit at a point between the throttle valve and the engine, means for superheating the steam delivered through said supply pipe to the device and a valve in said supply pipe for adjusting the proportion of steam supplied to the atomizing device relatively to the quantity delivered to the engine. Ten claims.

953,396. FURNACE. HERMAN A. POPPENHUSEN, OF CHICAGO, ILLINOIS.

Claim 1.—A furnace comprising an endless traveling grate and an ash pit, said furnace having a passage at the rear end of the grate for the descent of ashes from the said rear end of the grate into the ash pit, a horizontal partition located beneath said grate and extending from its forward to its rear end for receiving particles of unburned fuel which drops through the grate, said partition forming a longitudinal passage above the ash pit floor for the removal of ashes deposited upon the latter from the rear end of said grate, and conveying means located beneath the grate and above said partition and adapted to act on the top surface of the partition to scrape or carry forwardly thereon from beneath the grate such particles of unburned fuel. Three claims.

953,921. COMBINED STEAM-BOILER AND FURNACE. WILLIAM D. PLUE, OF RAINIER, OREGON.

Claim—In combination, a furnace, a vertically disposed water leg arranged over the fire box of said furnace, a longitudinally extending shell having the forward portion seated in said water leg and the forward end thereof projecting from said water leg, that portion of the bottom of the shell seated in the top of said leg constituting the top wall of said leg, that portion of the bottom of the shell seated in the top of said leg provided with a series of openings for establishing communication between the leg and the shell, a header positioned rearwardly of the back end of the shell and having its upper portion thereof arranged opposite the lower portion of the rear end of the shell, longitudinally extending tubes communicating with the upper portion of the shell, downwardly inclined tubes opening at their forward ends in



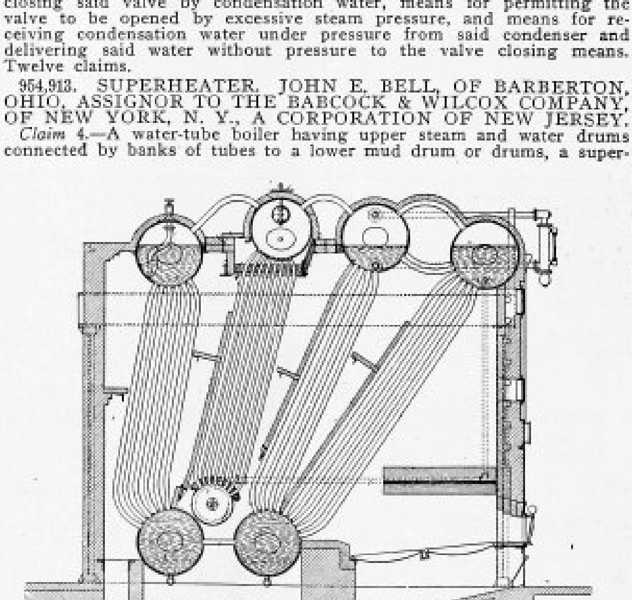
said leg and at their rear ends in said header below said longitudinally extending tubes, longitudinally extending fire tubes secured to the ends of the shell and extending throughout in a plane above the longitudinally extending tubes which establish communication between the shell and the header whereby an uninterrupted water space will be provided in the shell below the fire tubes, and an arch-shaped wall mounted upon the top of the header and extending to the rear end of the shell at a point above the fire tubes whereby a passage is provided for establishing communication between the rear end of the fire tubes and the furnace. One claim.

954,764. SAFETY APPLIANCE FOR STEAM-BOILERS. EUGEN ROTH, OF SCHONEBERG, NEAR BERLIN, GERMANY.

Claim 2.—A device for controlling the operation of boiler indicators comprising, in combination with a boiler indicating apparatus, a condenser connected to the steam space and to the water space of said boiler, a live steam pipe leading to said indicating apparatus, a valve for controlling the flow of steam through said pipe, means for closing said valve by condensation water, means for permitting the valve to be opened by excessive steam pressure, and means for receiving condensation water under pressure from said condenser and delivering said water without pressure to the valve closing means. Twelve claims.

954,913. SUPERHEATER. JOHN E. BELL, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

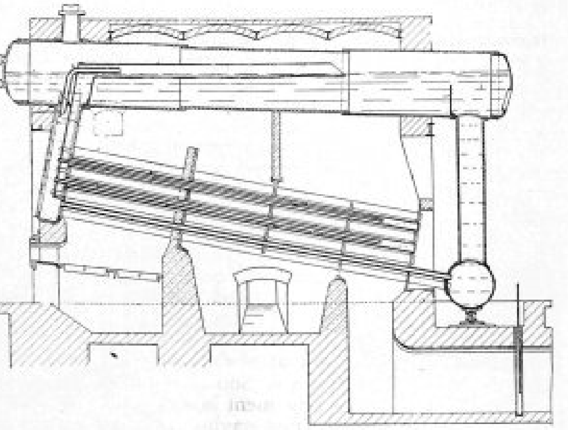
Claim 4.—A water-tube boiler having upper steam and water drums connected by banks of tubes to a lower mud drum or drums, a super-



heater having a drum or chamber with superheating tubes between the banks of water-tubes, partitions dividing the superheating chamber into different compartments, water circulators connecting two of the steam and water drums and located in line with the partitions. Fifteen claims.

956,388. WATER-TUBE BOILER. CARL MAHLKE, OF MODLING, NEAR VIENNA, AUSTRIA-HUNGARY, ASSIGNOR TO THE FIRM, ROHRENKESSELFABRIK MODLING, VORMALS DURR, GEHRE & CO., AKTIENGESELLSCHAFT, OF MODLING, AUSTRIA-HUNGARY.

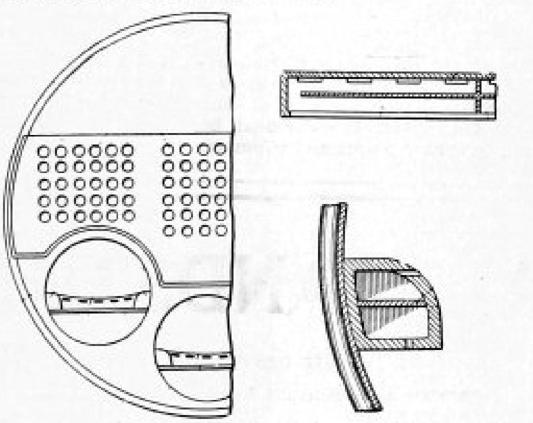
Claim 1.—A single header water tube boiler comprising in combination a divided water chamber, a system of Field tubes, the inner tubes of said system extending into the front half of said divided water chamber and the outer tubes of said system extending into the rear half of said divided water chamber, a steam drum, a mud drum, a downcomer connecting said steam drum with said mud drum, a nest of the usual water tubes, one end of the latter entering the said mud drum and the other end of said last mentioned water tubes entering the front half of said water chamber, said front half being closed off from the



steam drum, and one or more tubes adapted to connect the steam space in said steam drum with the front half of said divided water chamber. Two claims.

955,573. HOT BLAST FOR BOILER-FURNACES. PERKINS H. BAGLEY, OF SAN FRANCISCO, CALIFORNIA.

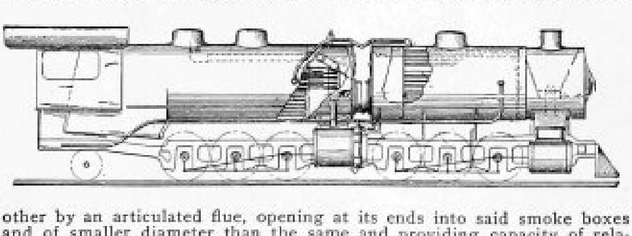
Claim 2.—The combination of a furnace having grate bars, a hollow body adapted to be placed on the grate bars, said body having two longitudinal slots in its under side and a plurality of horizontal slots in its upper side a web connecting the top, bottom and sides of said



body near the centre thereof, and a pair of webs connecting the first web and the two sides of said body and forming with said body a channel wherein air supplied to the furnace is heated before being projected thereinto. Two claims.

955,927. BOILER FOR ARTICULATED LOCOMOTIVES. HARRY S. VINCENT, OF RIDGEWOOD, NEW JERSEY.

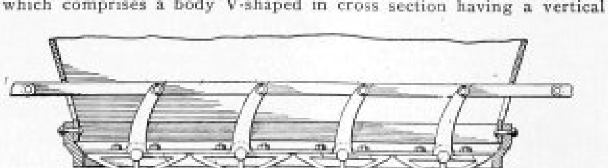
Claim 2.—A boiler made in two sections, each having a smoke box at its end adjoining the other, said sections being attached one to the



other by an articulated flue, opening at its ends into said smoke boxes and of smaller diameter than the same and providing capacity of relative movement of the boiler sections. Fifteen claims.

957,142. LOCOMOTIVE ASH PAN. ANDREW J. BRODHEAD, OF GREENVILLE, PA.

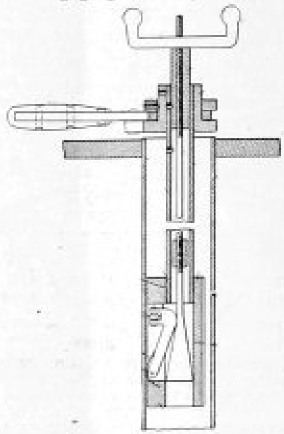
Claim 2.—An ash pan having a sectional tilting bottom, each section of which comprises a body V-shaped in cross section having a vertical



grid and two oppositely extending grids at each end, and a journal stud into which all grids converge and form a support for each end of the section, said grids also forming two openings in the ends of each section. Two claims.

956,805. TUBE CUTTER. EMANUEL CORNELIUS HELLER AND ARTENAOUS JEFFERSON EMRICK, OF GERMANTOWN, OHIO, ASSIGNORS OF ONE-THIRD TO WILLARD LINCOLN HUTCHINSON, OF GERMANTOWN, OHIO.

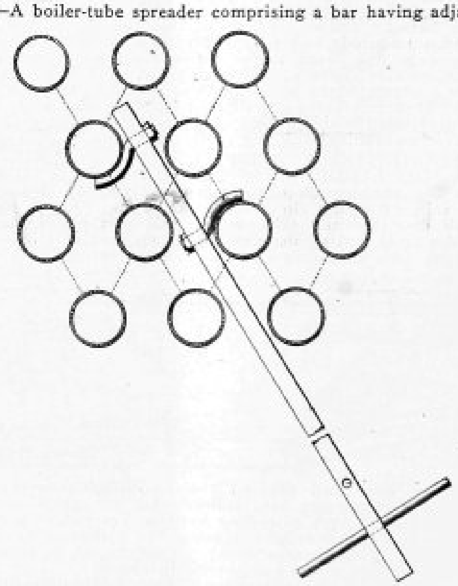
Claim 2.—In a tube cutter, a cutter head, a plurality of cutters carried thereby, an expanding member movable longitudinally through the cutter head, a tubular shank detachably connected with the expanding member and composed of a plurality of sections connected in axial alinement, means for guiding the expanding member through the tubular shank, a nut engaging the expanding member and bearing



against the guiding means, means for rotating the tubular shank and the cutter head, a supporting member for the tubular shank having an obliquely disposed shouldered flange, hook bolts extending through the flange, and means for supporting the tubular shank for rotation and against longitudinal movement with reference to the supporting member. Two claims.

956,985. BOILER-TUBE SPREADER. JOHN J. MAHER, OF PHILADELPHIA, PA., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

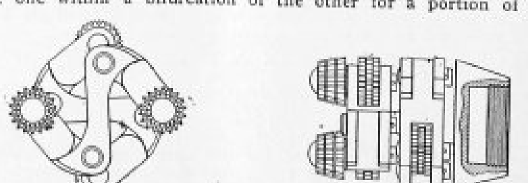
Claim 2.—A boiler-tube spreader comprising a bar having adjacent one



end thereof oppositely-extending curved arms, said arms lying on opposite sides of the bar and rigidly secured thereto. Four claims.

958,205. BOILER-TUBE CLEANER. GEORGE H. AINGE, OF SPRINGFIELD, OHIO, ASSIGNOR TO THE LAGONDA MANUFACTURING COMPANY, OF SPRINGFIELD, OHIO, A CORPORATION OF OHIO.

Claim—A cleaner head comprising a series of freely swinging pairs of arms, a support having a central post with oppositely-extending ears formed integrally therewith for each pair of arms, the respective members of each pair of arms being pivoted at one end to the outer ends of the ears, each arm and the ear to which it is pivoted being arranged to operate one within a bifurcation of the other for a portion of their



length, the arms being adapted to swing transversely to the axis of the head in the same plane with and on opposite sides of the ears, the free ends of the arms being bifurcated and provided with cutters pivoted therein and cutters on the front side of the forward pair of arms. One claim.

THE BOILER MAKER

AUGUST, 1910

THE STRENGTH OF RIVETED JOINTS.

Explanation Given by a Foreman Boiler Maker to His Apprentices.

Having been asked by a number of apprentices in the shop where I am employed if I would enlighten them regarding the calculation of the strength of riveted joints of steam boilers, I referred them to your valuable journal, of which some of them are subscribers, and they claim that many of the articles are too complicated for them. So I thought that as there are many others throughout the country like these young men who have failed to grasp the underlying principles, I would undertake to give in as simple a manner as I could, avoiding the use of complicated formulas, the rules and formulas which will give intelligent approximations within practical limits.

The strength of a cylindrical boiler shell to resist pressure within it, is in proportion to the diameter of the boiler and the thickness of the plates of which it is made. We will consider three boilers, each made of ½-inch plate, the first one 30 inches in diameter, the second 60 inches in diameter, and the third 120 inches in diameter. If the 30-inch boiler is fit for a safe working pressure of 180 pounds per square inch, then the 60-inch boiler will be fit for only one-half of that, or 90 pounds per square inch, and the 120-inch boiler will be fit for only half of that of the 60-inch boiler, or 45 pounds per square inch.

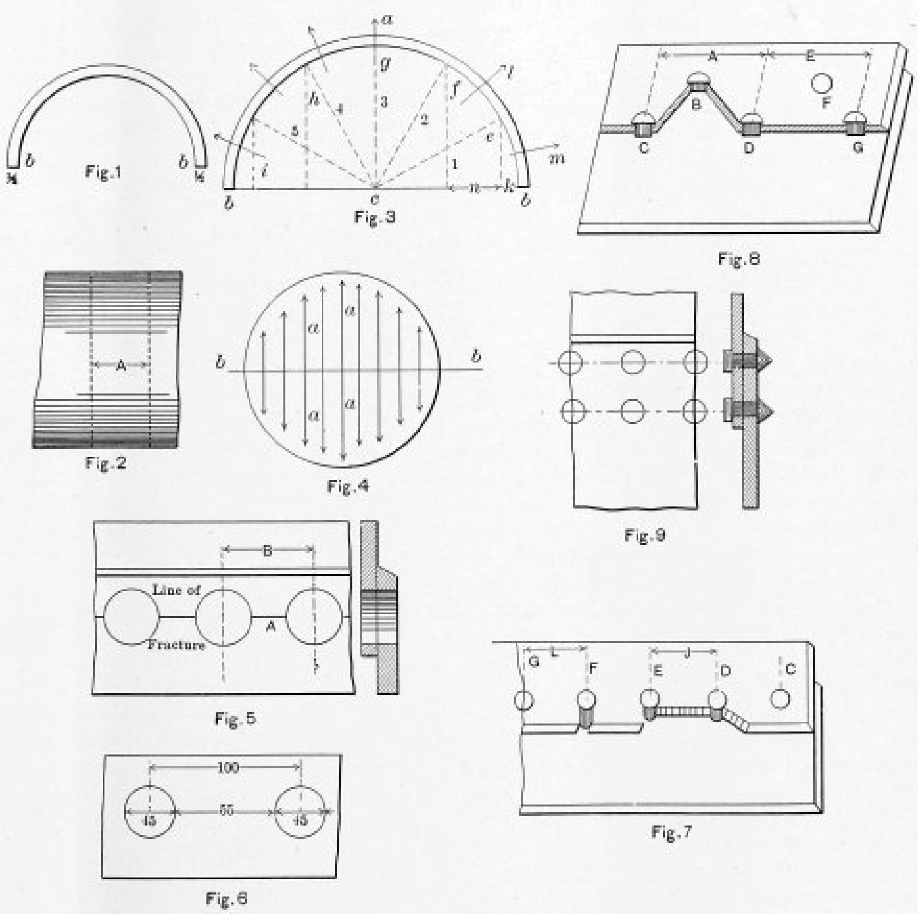


DIAGRAM TO ILLUSTRATE METHODS OF CALCULATING THE STRENGTH OF RIVETED JOINTS.

The same rule applies to the thickness of the plate, for if we take two cylindrical boilers, each 60 inches in diameter, the first one made of plate ½ inch thick, and the second twice that, or 1 inch thick, then if the first is fit for a safe working pressure of 90 pounds per square inch, the second is fit for a safe working pressure of 180 pounds per square inch, providing, of course, that the riveted seams are of equal strength in each case and both boilers allowed the same margin for safety.

These principles, namely, that the strength of a boiler is, all other things or elements being equal, in direct proportion to its diameter, and also in direct proportion to its thickness, afford us a groundwork from which we may lay down rules for determining, by calculation, the strength of the solid part of any boiler shell, and the basis of these calculations is as follows:

If the shell plate of a cylindrical boiler is ½ inch thick, there is 1-inch section of metal to be broken before the boiler can be divided into two parts; that is, there is ½ inch on each side of the shell, as shown in Fig. 1, and the two together will make 1 inch. If we take a ring an inch broad, as at *A*, Fig. 2, we shall have a section of 1 square inch of metal to break before the ring can be broken into two pieces.

The next consideration is, what is the average strength of a plate of boiler iron? Now suppose we have a strip of boiler iron 2 inches wide and ½ inch thick, or, what is the same thing, a bar of boiler iron 1 inch square, and that we lay it horizontally and pull its ends apart until it breaks, how many pounds will it bear before breaking? Now for our present purpose we may assume this to be 47,040 pounds, and if the number of pounds be divided by the diameter of the boiler in inches it will give the bursting pressure in pounds for any square inch in cylindrical shell of the boiler. The reason for dividing by the diameter of the boiler is as follows:

Of course the steam pressure presses equally on all parts of interior surface of the shell, and may be taken as radiating from the center of the boiler, as in Fig. 3, which represents an end view of a strip an inch wide of one-half of a boiler. Now leaving the riveted seam out of the question, and supposing the shell to be truly cylindrical, and the metal to be of equal quality throughout, it will take just as much pressure to burst the shell apart in one direction as it will in another, then we may suppose that boiler is to burst in the direction of the arrow *a*, and it is the section of metal at *b b* that is resisting rupture in that direction. Now suppose we divide the surface against which the steam presses into six divisions by lines radiating from the center *c*. To find the amount of area acting on each division to burst the shell in the direction of the arrow *a*, we drop perpendicular lines as line *e* from the points of the division to line *b b*, and the length of the line divided off (by the perpendicular) on the diameter represents the effectiveness of the area of that division to burst the boiler in the direction of the arrow *a*; thus for that part of the boiler surface situated in the first division, or from *b* to 1, the area acting to burst the boiler in the direction of *a* is represented by the length of the line *k*, while the general direction of the pressure on this part of the shell is represented by the arrow *m*. Similarly for that part of the shell situated between radial line 1 and radial line 2, the general direction of the steam pressure is denoted by the arrow *l*, while the proportion of this part that is acting to sever the boiler in the direction of *a* is represented by the distance *n*, or from line *e* to line *f*, measured on the line *b b*. By carrying out this process we shall see that although the pressure acts upon the whole circumference, yet its effectiveness in bursting the boiler in any one direction is only equal to the diameter. Thus in Fig. 4 the pressure acting in the direction of the arrows *a* (and tending to burst the boiler apart at *b b*) is represented by the diameter *b b*, while the pressure actually exerted upon the whole boiler shell is represented by the circumference of the boiler.

To proceed then it will now be clear that the ultimate strength of the boiler material, multiplied by twice the thickness of the shell plate in inches, or decimal parts of an inch, and this sum divided by the internal diameter of the boiler in inches gives the pressure (in pounds per square inch) at which the boiler shell will burst, and to put this rule into its first form, we may state it thus: Strength in pounds of 1 square inch of the material × twice the thickness of the shell plate in inches and parts of an inch ÷ by the internal diameter of the boiler in inches = the bursting pressure of the shell in pounds per square inch.

It is observed, however, that to avoid complication we purposely omit consideration of the reduction of strength at the riveted seam, which will be considered hereafter. We have here placed the calculation in the form of a formula, and as such formulas will be frequently used in the examples it is necessary to explain the use of various signs employed in them as follows: The sign + means added to, thus $8 + 8 = 16$, or $694 + 90 = 784$. The sign — minus or less, thus $8 - 2$ means 8 less 2, or 2 is to be subtracted from 8. The sign × means multiplied by, thus 8×2 reads 8 multiplied by 2. The sign = means equal to or amounts to, thus the equation $8 \times 2 = 16$, reads 8 multiplied by 2 equals or amounts to 16. The sign ÷ means divided by, thus $8 \div 2$ means 8 divided by 2, and $8 \div 2 = 4$, reads 8 divided by 2 equals or amounts to 4. When there is a line between two rows of figures it means that the figures or quantities above the line are to be divided by the quantities below it, thus $\frac{8 \times 5}{4}$ means that the 8 is to be multiplied by 5 and product divided by 4. The result is put at the end after an equality sign, and placed midway between the two lines $\frac{8 \times 5}{4} = 10$, which reads 8 multiplied by 5 is 40, and 40 divided by 4 equals, or amounts to, 10. In working out the figures all the figures or quantities above the line are to be worked out and divided by the quantity obtained by working out the bottom line, thus: $\frac{8 \times 5 + 10}{5 \times 5} = 2$, means 8 times 5 are 40, and 10 are 50, which, divided by 5×5 or $25 = 2$, or gives 2 as an answer. In some cases it is necessary to use a parenthesis in order to avoid mistakes in reading the figures, thus $8 + 4 - 2 \times 2$ should be read $8 + 4$ are 12, and 2×2 are 4, and $12 - 4$ are 8; but, by placing the doubtful quantity 2×2 in a parenthesis, thus $8 + 4 - (2 \times 2)$ we have separated the two quantities, and shown that 2×2 or 4 is to be subtracted from $8 + 4$ or 12.

All terms or figures in a parenthesis constitute one quantity, which is obtained by working out the figures within that parenthesis. The sign that is placed outside of a parenthesis determines what is to be done with the quantity within. If a quantity be placed outside a parenthesis without a sign between it and the parenthesis, it is to be multiplied by the quantity within, thus, $4\ (8 + 4)$ is the same as $4 \times (8 + 4)$. All these signs mean the same whether used above or below the line of the formula. To square a number is to multiply it by itself; thus 3 squared becomes 9, because $3 \times 3 = 9$. The square of a quantity is indicated by a small 2 placed above and a little to the right, thus 3^2 means 3 squared or 9. The square root of a number is indicated by the sign $\sqrt{}$, and means that we are to find a number such that when multiplied by itself will produce the given number; thus $\sqrt{9} = 3$, because $3 \times 3 = 9$. When the square root of several quantities is to be taken a line is placed over them, thus $\sqrt{16 + 9}$ signifies the square root of $16 + 9$, which is 5. The sign $\sqrt{}$ is called the radical sign, and is used to denote other roots besides the square root, by placing a small figure within the sign to denote the degree of the root which we wish to extract, thus $\sqrt[3]{}$ means the cube root and $\sqrt[4]{}$ the fourth root, etc. The quantity that is to have its root extracted is denoted by the length of the line, thus $\sqrt[3]{16 + 9 - 2} \times 4$ means that $16 + 9 - 2$, or 23, is to have its cube root extracted, and this root is to be multiplied by 4. When the radical sign applies to the quantities below the line of the formula the radical sign is also below the line of the formula,

thus $\frac{(60 + 5) \times (66)^2}{\sqrt[3]{3 \times 9} \times 2}$ means that 60 + 5 is to be multiplied by 66 squared, and the sum so obtained is to be divided by a number obtained by extracting the cube root of 3 × 9, which root is to be multiplied by 2. As the radical sign only extends over 3 × 9, therefore this only is the quantity to have its cube root extracted. If quantities above and below the line are to have the cube root extracted, the radical sign must denote it thus:

$$\frac{\sqrt{60 + 5} \times (66)^2}{\sqrt[3]{3 \times 9 \times 2}}$$

means that the square root of 60 + 5 is to be multiplied by 66 squared, and the sum so obtained is to be divided by a sum obtained by extracting the cube root of 3 × 9 × 2. When the square root or cube root of all the quantities both above and below the line is to be extracted, one radical sign may be made to apply to the whole formula, thus

$$\sqrt{\frac{8 \times 8 \times 3}{4}}$$

means that the square root of the quantity above the line is to be divided by the square root of the quantity below the line, or it means that the 8 × 8 × 3 is to be divided by 4, and the result so obtained is to have its square root extracted.

Suppose we take the strength of the iron to be 47,040 pounds per square inch, the shell plate to be ½ inch thick, and the diameter of the boiler to be 60 inches, and we have in a ring (such as *A*, Fig. 2) 1 inch broad just 1 square inch of metal to resist the internal boiler pressure due to a diameter of 60 inches, and, therefore, the sixtieth part of 47,040 pounds (or 748 pounds) is the pressure per square inch at which the ring will break or boiler shell burst, the calculation being as follows:

47,040 (strength of material per square inch) × ½ × 2 (plate thickness multiplied by 2) ÷ 60 (diameter of boiler in inches) = 784 bursting pressure in pounds per square inch.

We may now give the figures in full, thus:

Strength of material.
47,040
1 = ½ × 2

Diameter of boiler 60)47,040(784 = bursting pres. per sq. in.
420
504
480
240
240
000

We have now to consider the reduction of strength that the boiler undergoes, from the fact that the riveted seams are not as strong as the solid plate, because of the holes that are punched or drilled to receive the rivets. This is usually stated in the proportion the amount of plate left between the rivet holes bears to the amount of plate in one pitch measured from center to center of the rivets, or in other words by the proportion that *A* bears to *B* in Fig. 5, and also in the proportion which the cross-sectional area of the rivet bears to the total plate section, measured from center to center of the rivets, which cross-section would have to be broken or sheared off before the joint could break from the failure of the rivet.

When we consider the percentage of the rivet, however, we must deal, not with the diameter of the rivet, but with its cross-sectional area in proportion to the amount of cross-sectional area in a length of the plate equal to the pitch of the rivets, or if more than one row of rivets is employed in the joint, then we have to deal with the proportion existing between the total cross-sectional rivet area and the total cross-section of plate area in the pitch.

These proportions are always expressed by percentage, in the case of the plate section, how many parts in 100 are left or have been removed, as the case may be, or, in other words, if the whole pitch from center to center of the rivets be divided into 100 parts, how many of these parts have been removed by the punch or drill, and how many remain? If, as in Fig. 6, forty-five parts have been punched or drilled away, then fifty-five parts remain, or 55/100 of the plate section is left, which is usually expressed as 55 percent plate section. Now suppose the longitudinal seams to be riveted by a single row of rivets ¾ inch in diameter, the pitch being 1½ inches. If 1½ be divided into 100 parts we have removed 50 parts by the punch or drill, and consequently we have 50 left, or 50/100 of the total plate section left.

The pitch of the rivets is their distance apart from center to center, as denoted by the lines *C D*, *E F*, etc., in the single-riveted lap joint shown in Fig. 7, these lines passing through the centers of the rivets. The distance apart of these lines, as denoted by *J* or *L*, is one pitch. The number of rivets in one pitch is the number included between two of these lines, thus taking the pitch *J* it includes one-half of the rivet cut by the line *E* and one-half of the rivet cut by the line *D*, making in all one rivet. In case, however, of an ordinary double-riveted joint, such as the lap joint shown in Fig. 8, there are two rivets in one pitch, thus *A* is one pitch and *E* is also one pitch; *A* includes the rivet *B* and one-half of the rivets *C* and *D*, or two rivets in all. Similarly, pitch *E* includes rivet *F* and one-half of the rivets *D* and *G*, hence there are two rivets in one pitch. The rivets are arranged zigzag, as the rivets in one row are intermediate to the rivets in the other, thus *A* is between *C* and *D*, while *F* is intermediate between *D* and *G*. If the joint had chain rivets double riveted two rows of rivets, as in Fig. 9, there would still be two rivets in one pitch, because two lines drawn through the centers of the rivets would inclose four half rivets, which equals two rivets.

PATRICK J. SWEENEY.

A Warning.

A boiler explosion recently occurred at the works of the Vancouver Portland Cement Company, Tod Inlet, B. C. The boiler plant comprised eight return tubular boilers, 72 inches in diameter, with plates 9/16 inch thick. The boilers had been subjected to hydraulic test of 200 pounds per square inch, and were operating regularly under a steam pressure of 130 pounds. The explosion consisted of a rupture 21 inches long and 4 inches wide in the lower right-hand section of one of the boilers. The shell plate was considerably distended at the point of rupture, and the metal had bagged until it was only ⅛ inch thick. The cause of the accident was found in the blow-off cock, which was connected to a common header for all the boilers. This was of the asbestos-packed type, and a section ¼ inch by 4 inches had blown out, thus allowing the water in the boiler to escape in a very short time, causing overheating and consequent rupture of the shell.

The blow-off cock was a type which could not readily be inspected, and this accident emphasizes the necessity for having all boiler fittings placed so as to facilitate thorough and complete inspection. Fortunately the explosion resulted in little damage and no loss of life.

THE SELECTION, USE AND ABUSE OF STEAM BOILERS.*

BY BYRON CUMMINGS.†

The following remarks will refer principally to boilers and plants similar in size to those used by the average manufacturer. We deem this explanation necessary for the reason that many statements and suggestions which would be perfectly proper in referring to the average size manufacturing plant would be altogether inapplicable if applied to some of those that may be termed "high-tension" plants used principally for electric traction and lighting purposes.

Taking up the first part of our subject, "The Selection of Steam Boilers," we assume that we are entering upon a phase of the matter with which all of you have had more or less experience. We believe, also, judging by the experience of many others, that any information in reference to the subject will be appreciated.

AMOUNT OF POWER REQUIRED.

In the selection of steam boilers there are several points of almost equal importance to be considered by the power user.

Probably the first consideration is the amount of power required, and right here is where many intending boiler purchasers make a great mistake by not ascertaining accurately the amount of power necessary to properly perform the required work. We are not now speaking of a new plant, where these matters are looked after by a competent engineering authority, but of plants already in operation where new boilers are required to replace old boilers, or where additional boiler power is necessary.

Too often the owner reasons as follows: "I am now using 100 horsepower. I think 25 horsepower additional will be ample," and contracts for 125 horsepower. Now this method of reasoning would be all right provided the starting point was right, but was the starting point right? What method had been adopted to ascertain that 100 horsepower was being used? If the starting point was wrong, the conclusion is wrong. The owner may say, "I bought the boiler and engine for 100 horsepower, and have no reason to doubt that they are 100 horsepower." He may be right and probably is right if his engine and boiler were built thirty years or more ago; but an engine and boiler sold for 100 horsepower thirty years ago would probably be sold for 125 or more horsepower to-day. Besides it is not safe to rely on theoretical powers or performance when considering steam boilers and engines.

The proper plan is to start right by having complete indicator tests made, showing the power developed by the engine when running with full load. Make test with the engine running "empty." Then test with only the shafting running, also test the power required for each of the various machines in the plant.

If the shafting, or any of the machines require excessive power to operate them, ascertain and remove the cause.

After defects have been removed test again with full load, and if the tests have been properly made you will have accurate information as to the power you are using, and will, very probably, have remedied defects that will repay you by a saving in fuel, for the time and expense incurred in making the tests.

By making the necessary allowance to care for proposed additions to the plant, you will have definite knowledge as to the boiler horsepower necessary, and we think that the experience of the majority of those present will warrant the opinion that a generous addition to the necessary boiler capacity should be provided for future additions to the plant.

FIRETUBE VS. WATERTUBE BOILERS.

Having decided the question of the amount of power required, the question for consideration will probably be, "What type of boiler is best suited to my work?" If there be an engine that is to be retained the type of such engine may have much to do with the type of boiler necessary. If the engine is of the high-speed, high-pressure type your choice will probably be confined to a type of watertube boiler. If, however, the engine will operate economically at a pressure of not over 125 pounds you may choose either the watertube or the firetube type of boiler.

The amount of space available is often an important factor as well as the first cost of the plant, but the most important factor of all is: What installation will furnish the desired service at the least cost? And we have no hesitancy in stating that in our opinion there is, in the vast majority of cases, no better installation to be had than a set of correctly-designed and well-built horizontal tubular butt-riveted boilers. An illustration of a butt-riveted horizontal tubular boiler is submitted herewith. Fig. 1.

We believe that our opinion in this matter agrees with that of most members of your association, as inquiry develops the fact that nearly all of your members are using the horizontal tubular.

We do not wish to be understood that watertube boilers are not good boilers. On the contrary, many boilers of that type as at present constructed are very efficient. They will probably show a greater efficiency in steam production than the horizontal tubular type of boiler, but when the cost of installation, cost of operation and cost of repairs are considered, the watertube boiler has no advantage over the horizontal tubular, except, as previously stated, for the high pressures for which the horizontal tubular boiler is not available.

It may be claimed that the watertube boiler is a "safety" boiler, and that the horizontal tubular is not. There is some justice in this claim in so far as it refers to disastrous boiler explosions, but the watertube boiler is subject to considerably more of the minor class of accidents than is the horizontal tubular boiler, and one of the most destructive explosions of which we have knowledge was the explosion of six out of a battery of seven watertube boilers in St. Louis in 1904, entailing a property loss of nearly $100,000 and fatally injuring several people.

As an evidence of the economy in the operation of the horizontal tubular type of boilers we wish to cite the performance of a textile plant that has been in operation since 1848. There are twenty horizontal tubular boilers in the plant of about 50 horsepower each. The engine develops 800 indicated horsepower. The boiler plant has been renewed twice since 1880. At each renewal of the boiler plant, the representatives of watertube boilers were given to understand that their boilers would be given favorable consideration provided the builders would guarantee a saving in fuel over the horizontal tubular type. The plant had been supplying power at a cost of 3½ cents per horsepower per hour. The fact that watertube boilers were not chosen is good evidence that the required guarantee as to economy was not furnished by the builders of that type of boiler.

Having determined the capacity and type of boilers desired, the next consideration should be to provide reserve power, in order that some part of the plant may be kept out of service at frequent and regular intervals for cleaning and repairs.

With the average quality of water used for boiler purposes it is in our opinion impossible to properly care and attend to the boilers during the shut-down from Saturday night until Monday morning. One of the bad effects of such practice is excessive and sudden contraction of the parts of the boiler due to

* From an address before the Manufacturers' Association, of the City of York, Pa.

† Chief inspector if the Ocean Accident and Guarantee Corporation, Ltd., New York.

too sudden cooling off—caused by "blowing off" and "opening up," in order that boilers may be sufficiently cool by the next morning to enable men to work in them. After the boiler is cleaned, which is usually before noon, the boiler is filled again, very often with cold water. This sudden cooling of the boiler, with the consequent contraction of the tubes, shell, etc., cannot help but be harmful. The hurried work necessary under this plan is far from satisfactory, and the result is that the boilers gradually become more heavily scaled, and the fuel costs are increased, fire cracks develop and bulges and ruptures follow as a natural consequence.

If a steam boiler plant is to have the kind of care it should have in order to keep the cost for fuel at a minimum, and in order to prevent excessive repairs and rapid deterioration, it is absolutely necessary that there shall be provided facilities for properly cleaning the boilers, and we do not know of any better plan to accomplish this purpose than the installation of ample reserve capacity.

If your plant requires 100 horsepower, don't provide one boiler of 100 horsepower, and be compelled to shut down your plant every time repairs or thorough cleaning may be necessary. We have not overlooked the fact that repairs and cleaning on such a plant may be done on Sundays, but it is our experience that a large proportion of the plants so cared for do not receive proper care. Moreover, for six months of the year, in a one-boiler plant, the boiler is required to be continually in service to warm the buildings or to prevent water pipes from freezing, the result being that there is no opportunity to clean these boilers during the winter months.

A much better plan, and we think a more economical plan, when everything is taken into consideration, would be to install in such plant three boilers of 50 horsepower each, instead of one boiler of 100 horsepower; thus allowing one boiler to be kept out of service at any time for cleaning and repairs. In a plant as proposed the bad effects of sudden changes of temperature are reduced to a minimum, for the reason that several days may be devoted to gradually emptying the boiler, and after cleaning, the boiler may be refilled by water of the desired temperature through the feed-water heater. The life of the boiler will be prolonged, and the economy, due to the operation of clean boilers, should be saving money for the owner every day the plant is in operation. There is one point, however, that must not be overlooked. The owner must see that the facilties he has provided are properly used.

In this connection we wish to call your attention to a defect frequently met with in plants provided with reserve boilers, that nullifies to a great extent the time and money expended in providing facilities for boiler cleaning. This defect consists in defective main steam valves. It is practically impossible to satisfactorily clean a boiler when the main steam valve is leaking, and in consequence causing the boiler to remain hot and allowing hot water to drop on the cleaner. As main valves are seldom used they are frequently of a cheap and unsatisfactory kind. In our opinion this is poor economy. Reliable renewable-disc valves should be provided, for the reason that the operation of cleaning a boiler even under the best conditions is a dirty and disagreeable one. If to these conditions you add the danger of being burned by hot steam or by drops of scalding water it is useless to expect that your boilers will be kept in good condition.

After a boiler has been "down" and before it is closed it should be the duty of some one in authority at the plant to thoroughly examine and O. K. the work of the cleaners before allowing the boiler to be put into service.

We are thoroughly aware of the fact that a plant along the lines indicated is for various reasons not possible in many manufacturing establishments, and our remarks would be incomplete and unsatisfactory should we not endeavor to give some information in reference to approved methods for caring for the boiler plant that is not provided with a reserve boiler, and this matter will be referred to later on.

RIVETED JOINTS.

We have recommended that the longitudinal seams of horizontal tubular boilers should be of the butt-riveted type with inside and outside welt strips for several reasons. One reason is that a properly designed butt-riveted seam will be much stronger than any other type. A properly proportioned single-riveted lap joint seam will have a strength of about 58 percent of the solid plate. A double-riveted lap joint seam will have a percentage of about 70 percent of the strength of the solid plate. A triple butt-riveted seam about 85 percent and a well-designed quadruple butt-riveted seam will have a strength equal to 93 percent of the strength of the solid sheet. Another reason is that in a lap-joint boiler the inside of the shell does not form a perfect circle. Inasmuch as the natural tendency of the pressure inside of the boiler is to force the shell to conform to a perfect circle, an unusual strain is exerted at the "lap" of the seam, and many very serious explosions have been traced to the failure of such seams. With the butt-riveted style of construction the inner surface of shells conforms to a perfect circle, thus removing one of the most serious defects of the lap-riveted type of seams. Another reason is the fact that we have no authentic record of a boiler explosion caused by the failure of a properly constructed butt-riveted seam.

FITTINGS.

It appears to us that the objections to the use of domes outweigh any benefits obtained by their use. They weaken the boiler, they are condensers, and the "dry steam" they are supposed to furnish may be obtained by the use of properly designed dry pipe.

Our experience has shown that the use of mud-drums is ot very little, if any, advantage, and on account of the position in which they are placed, exposed to scale and deposits on the inside and to the action of gas and the accumulation of ashes on the outside, they form a menace to life and property, and we believe that their use should be abandoned. In this connection we beg to state that we do not here refer to the circulating drums of watertube boilers.

It appears to be conceded at the present time that the feed water should enter the boiler just a trifle below the waterline, and be distributed through perforations in the feed pipe, which, entering the front head, extends to within about 2 feet from the back head.

"Crosses" should be used in place of elbows on feed-water pipe exposed to the action of the fire and on water column piping. The unused ends of the crosses should be plugged with brass plugs with large heads. The ordinary iron plug is not suited for this purpose, as it "sticks" so tight that the square on the head of the plug is soon worn off. In Fig. 2 we have illustrated a type of plug which has given excellent results. They should be made of brass.

In order to prevent the clogging of water column piping, such pipes should always be of ample size, and we would recommend the use of 1¼-inch pipe.

As the safety valve is one of the most important parts of a steam power plant, more than ordinary care should be taken to have them of ample size and to keep them in working order.

There has been much discussion as to the proper shape, height and location of the bridge wall for horizontal tubular boilers. We believe, however, that it is now pretty generally admitted that the principal use of a bridge wall is as a backing for the coal on the grate, and that it is useless to have the wall any higher than is necessary for such purpose. Care should be taken that the bridge wall does not deflect the heat intensely against a girth seam, and that the draft is not choked by having the wall too high. We prefer a low bridge wall, sloped gradually upward, as shown in drawing (Fig. 1), in order that, when cleaning fires the live coal may be pushed back, the fire cleaned of clinkers and leveled, when the live coal may be pulled front again on to the fire.

INSPECTION.

The observance of certain precautions before a boiler is inspected is regarded by experts as of vital interest to the engineer of the plant and the person who is to make the examination. Cooling down, cleaning the combustion chamber, cleaning external and internal surfaces, and a proper arrangement of safety attachments should have careful attention. One practical way of dissipating the heat from the setting is said to be by means of cool air. "To accomplish this rapidly, all openings in the setting and flue doors should be closed and the damper and fire doors left open, or, in other words, the boiler left just as it would be in operation, with the exception of the firedoors." Another method (where possible) is to feed cool water "very slowly" and to open the blow-off valve "just enough to maintain the water level at some point in the gage glass; and not until the setting has properly cooled should the water be let out of the boiler." It is considered bad practice to blow out the water when the pressure falls to 5 or 10 pounds, and then cool the tubes and shell by a stream of cold water from a hose.

"After the setting has cooled sufficiently the ashes should be scraped out of the combustion chamber. Some engineers, instead of taking them out, make a practice of wetting them down with water and hose. This should not be done, as it damages the setting walls and it is dangerous for the inspector.

"Many a serious burn has been received by crawling into a combustion chamber which has been treated in this manner and sinking through a cold crust of 6 or more inches into red-hot ashes. Inspectors soon become wary of these conditions. It is really surprising how long heat may be retained beneath ashes in a combustion chamber. The writer has seen sawmill boilers, where wood was burned, which had been idle a week, and although everything was apparently stone-cold, red-hot ashes could be found a foot below the surface in the chamber back of the bridge wall.

"For proper inspection the grates of a boiler should be raked clean of ash and clinker, for it is extremely unpleasant and painful to crawl through a bed of clinkers, as anyone who has tried it can testify.

"In the vertical or locomotive type of boiler the grate-bars should be removed entirely, for corrosion is extremely liable to occur on the furnace sheets at the grate level, and a proper inspection can rarely be made with the grate-bars in place.

"The external surfaces of watertube boilers cannot be too well cleaned to aid inspection, unless it is at the tube ends, where accumulations caused by leaks may be present. These should be left to be cleaned by the person making the inspection. Such accumulations attract attention to the leaks, and the amount and nature of the accumulations assist the inspector in forming a correct opinion of the importance of the leaks. The foregoing reasoning applies to evidences of leaks at any point along the seams, shell or tube ends of all types of boiler. The blow-off pipes should be exposed for examination, as rapid corrosion frequently occurs on the piping to this attachment. The same reasoning applies to mud-drums, where such devices are used, and while it is advisable to protect them from the heat and ashes the protection should be readily removed to permit proper inspection.

"If the inspection is for the purpose of determining the cause of a bag, or a leak at a seam, or tube end, or any similar defect, the interior surfaces should not be disturbed until after the inspection has been made, for convincing evidence of the cause of such defects may be removed in cleaning. However, the boiler should be opened to permit drying out. If no defects as mentioned are known to exist the boiler should be scaled and thoroughly washed out. This applies especially to the bottom of the return-tubular type, where accumulations of scale make it difficult to detect grooving at the seams and other types of corrosion.

"A necessary condition to permit comfortable and thorough internal inspection, where other boilers are being operated at the time of the examination, is that the valves connecting the boiler with the steam main and feed line be tight. An excellent precaution is to have all the valves to these connections locked shut during the cleaning and inspection of a boiler.

"With the agitation for enactment of laws to prevent loss of life by boiler accidents, it would not seem amiss that such a requirement as locking the valves on a boiler during inspection and cleaning be added. This precaution also applies to the blow-off valve, where several boilers are connected to a single blow-off line, for doubtless the greater number of accidents due to scalding have been caused from this connection, owing to its apparent harmless nature, being on an open line. The experienced inspector soon learns to make it a fast rule, in plants where other boilers are in operation, to see that the blow-off valve on a boiler he is about to enter is closed, and he never takes anyone's word for it.

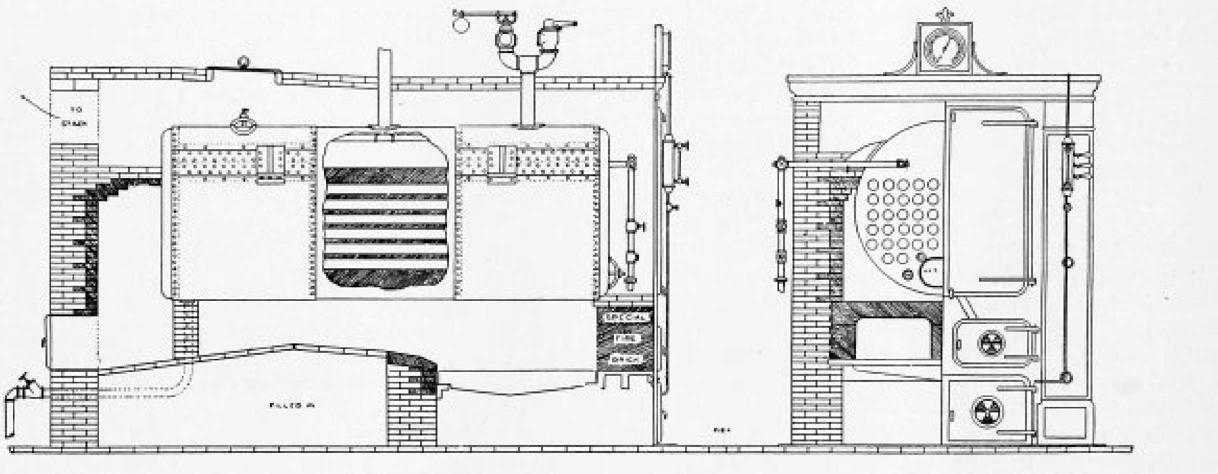


FIG. 1.

"Where safety valves are equipped with discharge pipes, they should be arranged so that a section next to the valve can be easily removed to permit examination of the springs and moving parts. The steam gage should be removed from the boiler, so it may be compared with a test gage, and any necessary corrections made.

"Except in rare instances there is no justification for placing in a boiler any apparatus which will interfere with easy access through the manholes, or proper inspection of the interior surfaces; if such conditions do exist, the attachment should be arranged so that it can be removed when an inspection is to be made."

TROUBLE DUE TO BAD WATER.

Our previous remarks indicate that probably one of the greatest sources of trouble in the operation of steam boilers is due to the impurities contained in the water used for boiler purposes. An analysis of the defects reported by the inspectors of one of the large casualty companies during 1908 shows that of 19,789 classified defects, 14,504 were due directly or indirectly to impure water.

The troubles are primarily due to deposits of sediment of various kinds on the shells and tubes. It is a well-known fact that if the tubes and shells are kept perfectly clean and the fire surfaces covered with water that it is almost impossible to overheat the metal in the boiler, but if a thin deposit of grease or other matter impervious to water accumulates on the shell or tubes, the part or parts so affected are easily overheated and a bulge or rupture ensues. Some deposits are more or less porous, and a considerable amount of this porous deposit may exist in a boiler without producing serious overheating, but any deposit will affect the efficiency of the boiler to a greater or less extent, and consequently it is of the utmost importance that effective measures be taken to prevent the formation of such deposits. In addition to the deposits on account of impurities contained in the water, we must also guard against oil and other foreign matter held in suspension by the water and carried into the boilers with the water.

A part of the matter held in suspension in the water may be removed by filtration or by the use of settling tanks, or open heaters. A large amount of the deposit is, however, caused by impurities that cannot be removed by filtering or by settling, and the bad effects due to the use of such water must be minimized by other methods.

The water in ponds, streams, etc., is composed in great measure from surface water, and water that has not come in contact with and absorbed mineral or other impurities to any considerable extent. Well water, however, having been taken from varying depths, has been in contact with and has absorbed a variety of mineral substances. In a limestone section the water will absorb considerable quantities of lime, and the deposits will be of that nature. In some of the Southern States there is a section in which the water is so alkaline that it causes foaming in the boilers in which it is used, the lime contained in this water being a negligible quantity. In some sections the water passing over decaying vegetation and other organic matter may become beneficial to boilers in which it is used for the reason that it forms a varnish-like surface that prevents scale and corrosion; at the same time being sufficiently porous to allow close contact of the water with the metal.

It will be observed, therefore, that well water, with its greater accumulation of mineral impurities, is usually the worst water for boiler purposes with which a boiler user must contend, and as we know that in this section of the country the use of well water for boiler purposes is a source of considerable trouble and expense, we recommend the use of water from some other source, for the reason that our experience has shown in many instances that a change from well water to city water has proven an economical move—notwithstanding the heavy water tax demanded by some municipalities. We could cite many instances in which boilers were operated at a disadvantage for several years with well water, because the owner felt that the charge for city water was exorbitant, and in each instance the owner was finally compelled to practically rebuild or renew his boiler, abandon well water and operate with city water. In our opinion, the cost of repairs and cleaning and the increased cost of fuel, due to the operation of a dirty boiler, will have been considerably more than if city water had been used from the beginning. We think that many power users do not appreciate the loss in boiler efficiency due to the operation of dirty boilers.

We had an experience with a dirty boiler several years ago, an account of which will, we believe, be interesting. The boiler had been in use in a heating plant for two years, giving perfect satisfaction. During the first cold snap of the third winter the owner 'phoned the shop that there was something wrong with his boiler; that he could not "raise any steam." The man who had installed the boiler was "put on the job," and proceeded to draw the fire, cleaned the ash-pit and tubes, took down and cleaned the flue between boiler and chimney and

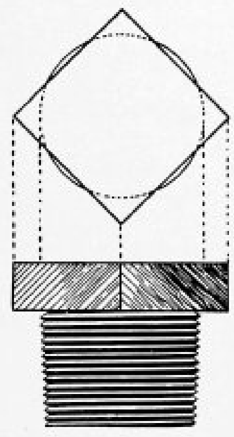


FIG. 2.

cleaned the chimney and started a clean, fresh fire. He had followed the usual practice up to this point, but as the weather was cold and the owner clamoring for heat, the boiler was not emptied. He felt confident, however, that he would have no trouble heating the building. To his surprise he was not able to generate a pound of steam with the hardest kind of firing. He then determined to put clean water into the boiler, emptied the boiler, refilled it with clean water and started fire the second time. An abundance of steam was generated with considerably less fuel than he had used in his first attempt. The fuel used in his first fire was practically wasted, and many boiler owners are wasting fuel every day because their boilers are not kept clean.

An indication of the excessive cost of fuel, due to the operation of a dirty boiler, is afforded by the result of a test described in *The Locomotive* of a boiler in good condition compared with the same boiler after it had become foul. In a four weeks' run the efficiency of that boiler fell off 10 percent, so that we think it is not unreasonable to assume that said loss distributed over the entire four weeks' period would be at least 5 percent.

The amount of foreign matter deposited in a boiler depends, of course, upon the quality of the water and upon the care and attention given to preventing deposits, but some boiler owners would be surprised at the large quantities of sediment frequently discovered in boilers by inspectors. In one instance, recently, a hand-saw was used to "saw out" the deposit between the tubes of a horizontal tubular boiler.

In another instance a boiler of about 40 horsepower had become so foul that the owner concluded to replace it with a new boiler. He sold the old boiler to a junk dealer, who hauled it 13 miles to his yard. Two teams were broken down during the trip, and when the boiler was cut up for scrap it was found to be nearly full of sediment. The junk dealer, who can vouch for the truth of this story, stated that the deposit weighed nearly as much as the boiler.

PREVENTION OF SCALE.

We may now consider the best methods for the prevention of scale and for reducing to a minimum the bad effects of impure water. When the plant is of sufficient size to warrant the maintenance of a water-purifying system, *i. e.*, an apparatus for filtering and purifying the water before it enters the boilers, such system should be adopted. In the large majority of plants the expense of such an apparatus would be prohibitive, and in such plants we must resort to the method of introducing into the feed water such chemicals or reagents as will prevent harmful deposits by neutralizing the action of the injurious ingredients contained in the water.

It is not our purpose to describe the chemical action of the various ingredients found in feed water, nor is it necessary to describe the chemical action of the reagents employed, as on account of ever-varying conditions the task would be an endless one. It is sufficient for our purpose that we outline a method of feed-water treatment that experience has shown to be effective under conditions similar to those under which the steam users of your association are operating.

Many years of experience has proven that soda ash, when used regularly and intelligently in connection with water similar in organic quality to that in use in your city, is a simple and most effective reagent. It is alkaline and neutralizes the free acids, preventing corrosion. It also neutralizes the bad effects of lime and magnesia forming sulphate of soda and carbonate of magnesia, which substances, being soluble, may in great measure be removed through the blow-off. It is almost impossible to state with any accuracy the amount of soda ash to be used in any given case. It will, of course, depend upon the kind of impurities in the water and the quantity of water used. We would, however, suggest a mixture of 1 pound of soda ash to 1 gallon of water—the strength of this solution to be increased or diminished as indicated by the condition of the boilers after trial for a reasonable period. It will be found in most instances that soda ash alone will be effective, but in cases where through neglect a large accumulation of scale exists, or when the water is unusually bad, caustic soda may be added in the proportion of 1 pound of caustic soda to 10 pounds of soda ash.

In starting the use of soda ash in a boiler somewhat scaled we should suggest that for a 100-horsepower boiler, 10 pounds of soda ash (dissolved) be placed in the boiler and about 3 pounds each day thereafter. Under the above conditions the boiler should be opened at the end of one week (or sooner) and conditions noted. The object in opening the boiler so soon is to prevent a dangerous accumulation of scale over the fire, due to the action of the chemicals. Continue the treatment along the same lines, increasing or diminishing the quantity of soda ash as conditions demand.

The formula given, in so far as refers to the quantity of soda ash to be used, is purely tentative and intended as a suggestion only. The requirements in each individual case must be determined by actual trial, and we wish to impress upon you the fact that satisfactory results can only be obtained by a regular, intelligent and persistent use of the methods suggested.

The soda ash should be dissolved in water (warm water is preferable) and may be fed to the boiler by feed pump, either through the pump, as shown by Fig. 3, or without going through the pump, as shown by Fig. 4, or it may be fed from a pail through the injector by using a piece of hose attached to the suction pipe of the injector.

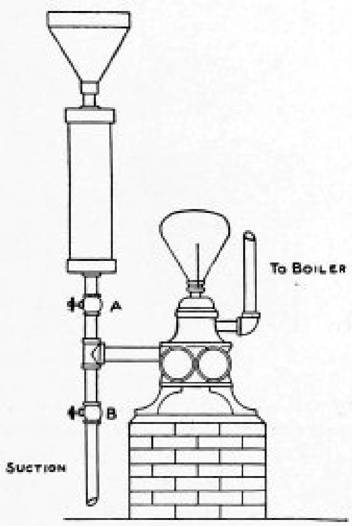


FIG. 3.

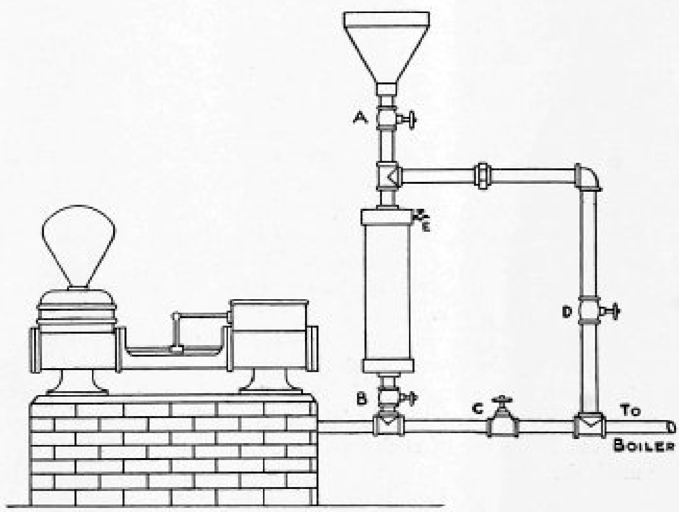


FIG. 4.

All boilers should be opened and washed out periodically. The frequency with which they should be opened depends upon the quality of the water being used. In some cases it is necessary to open and wash out each week; in other cases once in three or four months is sufficient. Intelligent observation will enable you to determine how often the cleaning and washing-out process is necessary.

Much injury has been done to boilers by "blowing out" under pressure, and such practice should be avoided. Fires should be drawn and boilers allowed to cool slowly, after which the blow-off valve should be opened and the boiler emptied.

Blow-off valves should be opened at a stated time, at least once each day in order to keep pipe clean and the valve in working order. Under certain conditions a considerable quantity of the deposit due to impure water may be removed through the blow-off, and in such cases frequent "blowing down" is advisable. In "blowing down" the valve should be opened "full" for half a minute, or longer, if conditions warrant it, but care should be taken to ascertain to what extent blowing down is advantageous. No fixed rule can be given, and too much "blowing down" is useless and wasteful. Care should be taken to open and close the blow-off valve (or any other valve) gradually. Serious accidents are liable to occur through neglect of this precaution.

After scale is removed from a boiler by any process leaks may "show up." These leaks are where the accumulation of scale had prevented leaks. Slight calking will usually close such leaks.

OIL IN BOILERS.

The use of crude oil as a scale solvent is strongly recommended in some quarters. Unless the engineer is well informed as to the dangers in the use of oil in a boiler we would not recommend its use. There is no use denying the fact that crude oil (*i. e.*, pure well oil) is a good scale loosener. The liability to injury to the boiler, however, on account of the use of adulterated oil makes it necessary to know the quality of oil being used. Impure oil may cause a deposit on the shell or in tubes that will prevent the water from coming in contact with the metal, and bulges will result. We have seen bulges, due to the use of oil, where the deposit was not 1/16 inch in thickness. Another source of trouble from the use of oil in boilers is on account of the formation of dangerous gases. Accidents from this cause are frequent. Our attention was called to one that happened recently which very seriously burned an inspector and an engineer of the plant. As a general proposition we think that oil should be kept out of boilers, as it is of value in exceptional cases only.

An examination of the plan attached of apparatus for feeding compound to boilers will advise the engineer of a safe working method which can be used regularly and with little trouble after the apparatus has been installed. We would recommend that a piece of 6-inch pipe be used for the receiver, with caps on each end tapped for pipes to suit the size of the pump and for a good-sized funnel on the top. These sizes are not important, any size piping or receiver may be used as will best suit the various conditions of the different plants. We prefer the apparatus described in Fig. 3, and suggest that in using it a fine mesh wire screen be fitted into the funnel in order to prevent gritty matter from getting into the pump. In the use of this apparatus it is only necessary to fill the receiver with the dissolved compound, close valve *B* and open valve *A*, until the receiver is emptied by the pump. Afterwards the valve *A* may be closed and valve B opened and the pump resume its normal function. In the apparatus described in Fig. 4 the process of operation is somewhat more complicated; to feed the compound the pump should be first stopped and valves *B*, *C* and *D* closed and valve *A* opened. The receiver should then be filled with the dissolved compound and valve *A* closed, after which the valves *B* and *D* may be opened and the pump started. This proceeding will feed the compound quickly, after which the pump should again be stopped and the valves *B* and *C* opened and *D* closed, after which the pump may again be started on its regular work. A plug or pet-cock should be tapped near bottom of receiver for draining it.

The number of times and the quantity of compound to be used will depend upon varying conditions, and no definite rule can be given. The engineer must mix brains with his compound, and with his examination of the boiler at frequent intervals, particularly when first beginning the use of compound, and determine the quantity and frequency of its use by conditions and results obtained.

We wish to state in this connection that no matter which solvent for preventing or removing scale is used, it must be assisted with a good quality of brains. No process will be successful unless it is persistently adhered to and intelligently and systematically conducted.

SAFETY VALVES.*

The remarks and suggestions below relate to locomotive boilers only. Further, they relate only to locomotive boilers using coal as the fuel, and under the conditions now prevailing for the stimulation of the draft by the use of exhaust steam from cylinders of the locomotive and by means of the ordinary steam blower. A series of tests were made for the committee by E. D. Nelson, engineer of tests of the Pennsylvania, to determine the maximum or worst condition that the safety valves were required to take care of. With gage pressures of 190 to 207 pounds, it was found that the maximum discharge of steam was 2.44 pounds, the minimum 1.18 and the mean 2.05 pounds per square foot of heating surface per hour.

The committee has taken twice this mean value as the basis of a formula, which, in its opinion, will reduce safety-valve practice to a uniform basis, and at the same time provide proper relief for the boilers. Such a formula may be expressed as follows:

$$A = \frac{0.08 \text{ H. S.}}{P}$$

A = Outlet of valve in square inches.
H. S. = Boiler heating surface in square feet.
P = Absolute pressure = gage pressure + 15 pounds.

This formula will provide, on boilers carrying 200 pounds gage pressure, an outlet that will take care of 4.1 pounds of water per square foot of heating surface per hour.

A number of observations were made on locomotives in passenger service, provided with safety valves the combined outlets of which would take care of from 3.64 to 4.06 pounds of steam per square foot of heating surface per hour, and no cases were found where the safety valves failed to properly relieve the boilers. The locomotives on which investigations were made carried 200 pounds gage pressure, had 4,231 square feet of heating surface and 56½ square feet of grate area. Past investigations have verified that Napier's rule for the flow of steam may be safely taken for the types of muffled safety valves now on the market. In the formulas below we have used for arriving at results 215 pounds absolute pressure, or 200 pounds gage pressure.

SUMMARY OF FORMULAS.

No.	Authority.	Steam Pounds, per Hour, per Square Foot, H. S.	Remarks.
1	Am. Ry. M. M. 1908 Report (proposed): $\text{Area} = \frac{0.10266 \times \text{H. S.}}{P}$	5.28	For argument in support of this, see Am. Ry. M. M. Proceedings of 1908, page 262.
2	Am. Ry. M. M. 1910 Proposed by Committee: $\text{Area} = \frac{0.08 \times \text{H. S.}}{P}$	4.10	Recommended by the committee. Arguments in support of this and its limitations herein.

In the formulas above the area is area in square inches. *H.S.* indicates total heating surface in the boiler in square feet. *P* represents absolute pressure or gage pressure plus 15 pounds.

It is, perhaps, superfluous to state that, having assigned proper values for safety valves, means should be provided for maintaining the values. In other words, the maintenance of proper areas of outlet should be a feature of safety-valve maintenance and repair. For the guidance of the designer, the valve manufacturers' lists should show nominal size of valve, the outlet in square inches under various pressures, and the capacity for discharge of steam in pounds under the various pressures. For the guidance of the repair man, the lifts of

* Report of committee presented at the forty-first annual convention of the American Railway Master Mechanics' Association.

valves under the various pressures should also be shown. The committee considers that safety-valve outlets to either of the above formulas will be satisfactory if used as prescribed in the opening of this report.

THE ADVANTAGES OF THE WIDE FIRE-BOX OVER ITS PREDECESSOR, THE NARROW.*

BY C. H. VOGES.†

The wide fire-box gives a more equal expansion, is easier kept clean and has less leaky and broken staybolts.

After the narrow fire-box is in service six or eight months the flanges of the back flue sheet crack from the rivet holes to the calking edge, caused by draft of engine forcing heat against the flange before it passes through flues, making it necessary to hold engine in, remove rivets, scarf sheet and re-rivet or apply patch bolts or plugs; while in the wide fire-box it is a very rare thing to find the flanges with fire cracks, because the heat, instead of being drawn against the flange, passes directly through the flues where it does the most good.

The wide fire-box has a greater grate surface than the narrow, and it is easier to draft an engine to make them burn an even fire. It is also much easier for the fireman on account of the distance he has to shovel the coal and to keep a good fire against the flue sheet, causing less failures on account of flues leaking.

Now another comparison I wish to make is the matter of keeping the boilers clean. In the wide fire-box with the side sheets almost straight, it is practically impossible for scale to lodge on staybolts, but will drop from any part of boiler over the fire-box to water bar, where it can be easily washed out, while in the narrow fire-box when the heavy scale becomes detached, it will in nine times out of ten lodge on the staybolts, causing mud to form, and if allowed to remain the side sheets will become mud burned and crack, making it necessary to take the engine out of service to plug cracks or patch.

As to the widening of the water leg to prevent side sheets from cracking, in my opinion would result in a failure, as the water would bubble away from the side sheets with an eighth inch water leg the same as from a four-inch leg when the engine is in service, and if it did not there would be no circulation.

We have engines in both freight and passenger service for four and five years with the wide fire-box that have no cracks in fire-box; on the other hand, the engines doing the same service with the narrow fire-box will in three to four years' time have received half side sheets or will have several patches on them.

To overcome the cracking of side sheets, my advice is to keep the boilers clean, and the only way to do this is to make the round house boiler maker responsible for the boiler washing. When he sees the good results and the manner in which it lightens his work on the fire-boxes, he will not allow the boilers to go out half washed, but will take the time to see that they are washed thoroughly. The result will be that the cracking of side sheets will be reduced about forty percent.

I would recommend two rows of flexible staybolts above the horizontal seam on account of the rigidity of this place. We discovered more broken staybolts at this point than any other place; 223 broken staybolts were removed on the high pressure boilers in one year. In five years' time we removed 2,200 caps to test the flexible stay-bolts and found only three bolts broken.

* Paper read before the International Railway General Foremen's Association, Cincinnati, May, 1910.
† General Foreman, C. C. C. & St. L. R. R., Bellefontaine, O.

Quick Boiler Work.

We have recently had two instances of smart work in connection with boilers brought to our notice. These have been carried out by the firm of John Thompson, of Wolverhampton, at the East Kent Collieries. The first consisted of the supply and erection of a Thompson dish-end Lancashire boiler, 30 feet long by 8 feet 6 inches diameter, fitted with corrugated flues, together with the steam feed and blow-off piping, and brickwork. This boiler was urgently wanted, and was in stock, ready for almost immediate despatch, when the order was given. Nineteen days later it was steaming and at work, the piping and brickwork complete. The steam pipes included an extension of a 12-inch ring main, and to save loss of time in having "make-up" or template pipes, the makers erected the 12-inch main, and then set the boiler to come exactly in line. The second instance occurred in connection with a steel chimney. Six Lancashire boilers were connected to a brick shaft, and it was necessary to increase the draft, but any stoppage was not permissible. The new steel chimney was erected, and the flue joined to the old brickwork, the arch of the old main back flue being supported by heavy cast iron plates, these plates being inserted by cutting away just enough of the wall to allow them to be placed in position without interfering with the draft. When the new shaft was ready, full steam was raised on all the boilers and the dampers closed. The access doors to the back flue were then opened, the old shaft bricked up, and the dividing wall to the new flue and chimney knocked down, this being possible because of the iron plates supporting the arch. The change over was accomplished in thirty-four minutes, and the steam speedily rose to full pressure when the new chimney began to pull.—*The Engineer.*

Horizontal Tubular Boilers with Steel Dutch Oven Setting.

Six horizontal return tubular boilers, 84 inches by 18 feet long, built for 150 pounds working pressure, have recently been shipped by the Casey-Hedges Company, of Chattanooga, Tenn., to the Colorado Salt Company, Colorado, Tex. These boilers are of interest for two reasons. In the first place, they represent the highest type of design and workmanship for the horizontal tubular boiler, and no boiler maker could give them even a hasty inspection without being impressed with the high class of workmanship which has been employed in their construction. The second point of interest is that they are to be equipped with a steel Dutch oven setting. This is a patent setting manufactured by the Casey-Hedges Company, and is claimed to eliminate all the objectionable features of the brick Dutch oven as well as reducing the first cost very materially. A steel boiler setting can be made practically air tight, and therefore there can be no loss of economy due to leakage of air through faulty brick work to spoil the combustion. This type of setting is designed as the result of long experience in the burning of refuse fuel. The settings are designed, however, for burning all different kinds of fuel, and have become so popular that the manufacturers now supply about 90 percent of their orders with these casings.

Besides being a source of economy these casings when erected are an ornament to a boiler plant, and instead of unsightly cracks in brick walls, which are very commonly seen in boiler rooms, the steel casing always remains in good order, and, with a fresh coat of paint, looks clean and neat in a well-kept boiler plant. The Casey-Hedges Company have a large sheet iron shop expressly for the manufacture of these casings.

JAMES J. FLETCHER.

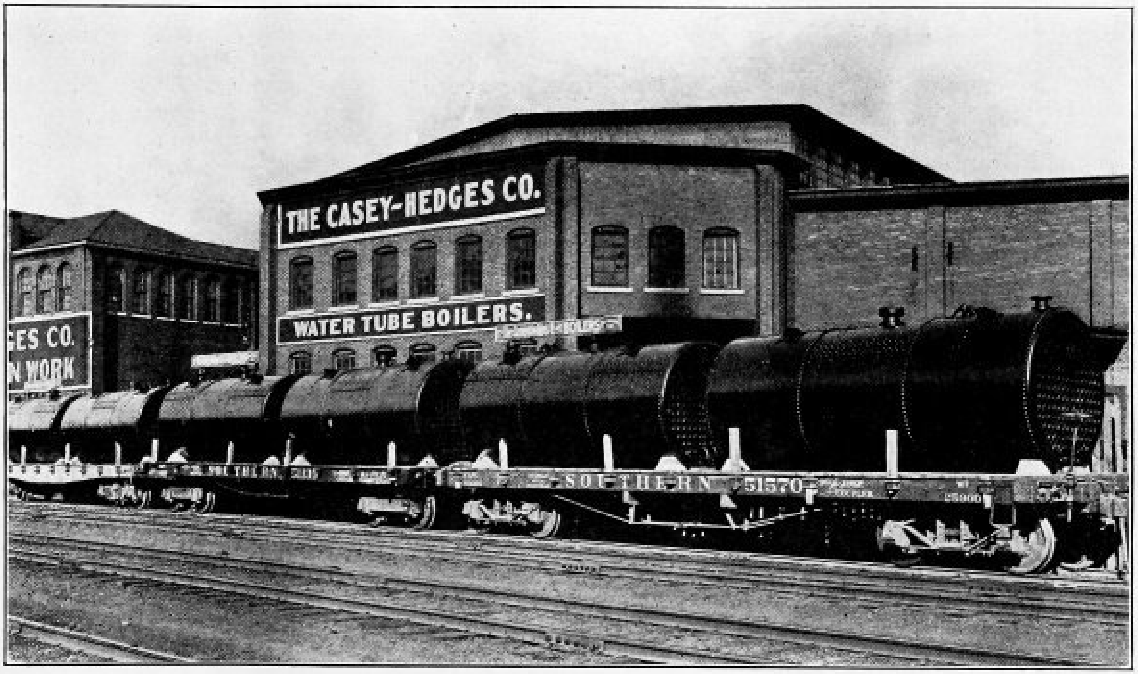
PROBABLE CAUSE OF RECENT EXPLOSIONS.

BY T. T. PARKER.

Reviewing the Canton boiler explosion, as described in the May 31 issue of *Power*, we may accept as conclusive that the boiler failed by the shearing of the rivets at both longitudinal seams, which were of lap-joint and double-riveted construction. The shell was built in two sheets, each extending from head to head, the joints or seams being on each side below the lugs, and, of course, below the upper row of tubes, so that each longitudinal seam was inaccessible for inspection, either externally or internally.

The feature of special note is that this is the third explosion within a few months of boilers built with one sheet on the bottom extending from head to head. The boiler that exploded at the Robinson clay product plant, Midvale, Ohio, in December, was built in the same manner, and the boiler that exploded about the same time at Shelton, Conn., was built with one sheet on the bottom. In 1902 a boiler built in this manner exploded at the Swift plant in Chicago, killing thirteen men and injuring several others. Also in 1898, or 1899, another similar boiler exploded at Willy's mill, Appleton, and resulted in heavy property damage and the killing of one man. The initial fracture of the latter took place at the long seam, while the Swift boiler failed on top in the solid plate from head to head. Probably other explosions of boilers built in this manner have occurred that the writer has no knowledge of. It is the purpose of this discussion to point out the defects in this type of construction and the bearing such matter would have upon boilers of similar construction now in operation, with the hope of pointing out reasons that may explain such explosions with a view of possibly preventing future explosions. The publicity given to boiler explosions, together with the vast number of intelligent engineers and superintendents who read and assimilate the articles in *Power*, prompt me to place my views before them, knowing that if I am in error as respects the conclusions, the mistakes will be pointed out. If, otherwise, perhaps, an explosion will be averted.

In the construction of a cylinder the plates composing the shell must be cold-rolled into circular shape. Consider the ordinary boiler shop rolls used for this purpose; the upper roll being the adjustable one. The flat boiler plate enters at one side, and is passed along under the upper roll until it strikes the second lower roll. It is evident that the plate is not curved from a point perpendicularly below the center of the upper roll to where the plate touches the second lower roll. It is also evident that the edge of the plate directly opposite to that first entering the rolls will have a flat, uncurved section, and the width of each section will vary with the diameters of the rolls. Large-diameter rolls are needed for heavy plates and for long plates. With plates rolled to form one-half the circumference and 16 or 18 feet long, the diameters of the rolls must be increased to prevent springing in the middle; the rolls being supported at the ends only. Even then, with sheets of this length, we find considerable springing, as may be expected with cold rolling. With hot rolling difficulty is also experienced, the plates increasing in width as is evidenced by the mills requiring larger percentage as regards thickness.



SHIPMENT OF HORIZONTAL RETURN TUBULAR BOILERS TO BE EQUIPPED WITH STEEL DUTCH OVEN SETTINGS.

To curve the flat section at each end of the plate where the horizontal seams are located is a most important object. In many instances the sledge is used for this purpose and the metal mauled into a rough, irregular shape. S. F. Jeter described in *Power*, Dec. 21, 1909, the results of this found on the seams of a boiler wherein one plate formed the full circle, and showed with illustrations the actual deformation along the line of the horizontal seam. But with a sheet forming half the circumference and allowing for the spring of the rolls, it would appear reasonable to expect the plate to be more out of a true circle than would a full-course sheet. Consider then the effect of one sheet on the bottom as compared with a plate forming a full circle but only 6 or 8 feet long. True, some shops use special tools to force the plate evenly into a circular shape. Also, other shops use a section of very heavy plate as a liner over the lower rolls, placing the sheet on this liner to finish the operation. But this is impracticable with sheets 16 feet long and rolled into half circles.

With a boiler built either in full-ring course or in half sheets extending from head to head, the importance of having the plate truly curved to the proper radius cannot be underestimated. If this is not done the continual flexure or bending action will eventually result in failure at the joint regardless of whether the seam be a butt, strap or lap joint; for the wider the joint then the stiffer it will be. Indeed, we might expect less trouble with a single-riveted lap joint, as it would to some extent act as a hinge. Not that I advocate such a joint, but it is mentioned in order to discuss the effects of this flat section.

If we design a boiler 16 feet long to be built in three courses the breaking joints are on opposite sides, and we secure the benefit of the girth seams in stiffening the shell, with the weak sections—the horizontal seams—away from each other. Then we have but 16 feet of longitudinal seam, whereas with the "one-sheet-on-bottom" boiler we have 32 feet of weak section without any circular seams to support it. Consider the hoops in a barrel as an illustration of the principle applied to a boiler. In the three-course construction the weak sections of the seam are not continuous. In this form of boiler the long seams are placed above the tubes in the steam space, where they can be examined both internally and externally.

I believe that beyond question, boilers having one sheet on the bottom are structurally weaker, regardless of rules for determining the safe working pressure, than boilers built in courses. Details may vary with different explosions of boilers built in this manner. In the Canton explosion the rivets sheared, the plate being 3/8 inch and the rivet holes 13/16 inch with a pitch of 3 inches. Other details of the joint were not given. Assuming the usual flexure, it may be that the plate was better or stronger than the shearing resistance offered by the rivets, and the latter received the effects of the bending action.

Looking further into boiler construction, assume a 1/2-inch plate to be rolled to 72 inches diameter. The outer circumference would be 226.19 inches, the inner 223.05 inches; that is, one side would be 3.14 inches longer than the other. Stresses are thus set up that cannot be determined to a certainty. Some little is known of the molecular grouping of steel and of the cohesion of the molecules, wherein rests the strength of the plate. When the molecules begin to slip apart and loosen their hold upon one another we say that the limit of elasticity has been reached, and we avoid loads that will produce this result. In a 72-inch diameter boiler with 1/2-inch plates, shall we say that the metal at the inner side of the plate has become denser, or what would appear to be more correct, that the cohesion of the molecules at the outer side of the plate has become lessened? It will be noted that this bending action is on a line parallel to the axis of the cylinder and in the path of the horizontal seam. It is usually contended that the factor of safety takes care of these stresses, but we may define this factor of safety as one representing a "factor of ignorance" of something of which we have no correct knowledge.

Looking further into the subject, let us consider the question of punched rivet holes as regards injuring the net section of the plate between the rivet holes and as to whether the joint should be a lapped or a double-butt strap. Specifications calling for the holes to be drilled, or if punched, to be reamed out 1/4 inch, are ridiculed as old fashioned. English practice, as well as United States marine rules, recognize the injurious effects of flat punching. W. S. Hutton is authority for the statement that through punching the loss in tenacity is 8, 18 and 26 percent for plates 1/4, 3/8 and 1/2 inch, respectively. We need accurate data on the subject, but doubtless we shall find that the holes had best be reamed 1/4 inch full when assembled.

If one concedes even part of what has been said in this discussion, then the question follows: "What should be done regarding boilers now in operation and constructed with one sheet on the bottom?" May I suggest the value of the hydrostatic test, even granting this may set up strains tending to weaken the boiler? A test applied under the eye of a competent inspector and with the brickwork removed, in order that both seams can be examined, appears to be the best way; and the engineer should afford the necessary facilities for such a test. Also, he may easily provide wooden curves properly supported and struck from a radius, say, 2 inches longer than that of the boiler, and use these to note the proximity to a true circle of the boiler shell, both under and without pressure.

The factor of safety for boilers of this type should be greater than for those built in three courses, regardless of rules. This factor should be increased 20 percent when the "one-sheet-on-bottom" boiler is ten years old. In addition I am so convinced of the structural weakness of boilers of this type that I believe no more boilers should be built on these lines, and that it is the duty of persons operating or owning such boilers to replace them with new ones designed on better lines.

Doubtless many will say the case has not been proved beyond the point of a doubt. Even so, the fact remains, singular, sinister, and not otherwise explainable, of three disastrous explosions of boilers within a few months built in this manner together with others herein mentioned. Evidence of so strong a nature surely demands consideration.

The annual meetings of the several associations devoted to steam engineering in its various branches will soon take place. In view of the alarming number of boiler explosions would it not be well for them to devote some attention to a consideration of what may be done to assist in preventing further explosions of this kind?—*Power and the Engineer.*

COPPER AND STEEL FOR LOCOMOTIVE FIRE-BOXES.

At a meeting of the Western Canada Railway Club a paper on this subject was read by Mr. H. B. Lake, chemist to the Western Pacific Railway. The author said that sheet copper weighed one-eighth more than sheet steel. Assuming the price of steel at 3 cents and copper at 21 cents, then copper costs seven times as much as steel, and as the thickness of the sheets of copper used in a fire-box was generally about twice that for steel, the initial cost of the material for the copper box would be a maximum of sixteen times that for a steel box. Allowance, however, had to be made for the value of the scrap copper, which locally was stated to be 75 percent, and allowing 5 percent of this for the steel scrap, this reduced the ratio of the cost of the copper plate to about five times that of the steel. As regards the labor cost of making the box, this was in favor of copper. Being the easier metal to work, it induced less wear and tear on tools, and in addition the time required to make the copper box was less. Where cost of labor bore a high ratio to cost of material then this factor would increase in importance.

The possible life of the two fire-boxes depended largely on local conditions. The life of copper boxes on English roads was about ten years, or the equivalent of about 800,000 miles, and copper tube plates last about five years in hard, constant service at high pressure. Steel boxes, under similar conditions, give a life of only one year, or about 80,000 miles, before requiring repair, and on a certain section of the Canadian Pacific Railway, where the water supplies were of medium quality, the side sheets of steel boxes in new engines required renewal inside twelve months, or after running about 45,000 miles. Hence the labor expended in making steel boxes was as much, or more, than in making copper boxes, and totally, with labor for repairs, it was safe to assume that it was five times as great. Where labor costs as much, or more, than the material used in the box, this reduced the relative cost of the two boxes to about the same figure. This reduced the considerations to the relative time engines fitted with either kind of box would spend in the shops directly consequent to the copper or steel fire-box. Evidently, if a steel box required more frequent repair the comparison would be in favor of copper.

Another important consideration was the greater reliability of one material by which engine failures, or delays, might be less than with the other. Copper is more resistant to corrosion than iron, being higher in purity than mild steel, and electrolytic copper, while equally as ductile and tenacious as that produced by smelting and rolling, was even purer. Pure iron, and more readily steel, was dissolved by pure water, and when carbonic acid and air were present the action was accelerated. Also the impurities in the steel were segregated, and were more readily acted upon by local electrolysis, producing pitting. Copper was not acted upon by pure water at any temperature, and even resisted the action of hydrochloric acid if air was absent, and was far more resistant to corrosion than steel.

As to tensile strength, copper was almost equal to very mild steel, and in ductility very much higher. It was, therefore, less physically damaged by the punishing operations of riveting and beading than steel, and made a tighter and more tenacious joint than steel with the tubes or flues. This superiority was demonstrated in a series of tests made by Mr. J. A. Holden, of the Great Eastern Railway, England. He expanded steel flues into copper and steel plates, and then pulled the plates. Out of twelve tests the tubes started in the steel plate ten times, and finally eleven tubes pulled through the steel, while eleven remained tight in the copper plate. The tubes were expanded in taper and straight holes, the former giving more uniform results. The plates used were copper, 1¼ inches thick, and steel ¾ inch thick. No ferrules were used. Beading over did not improve the hold in steel plates, but increased the tenacity in copper plates from 7 to over 12 tons pull required to remove the tube.

Mr. B. A. Raworth pointed out that the merit of the copper fire-box was that it lasted a long time; the material was exceedingly tough and plastic, and withstood the very severe strains caused by differences of temperature without exhibiting fatigue. In addition, the screwing of ¾-inch or ⅞-inch stays into a ⅜-inch steel plate could never be made a secure job, although in the ⅝-inch plate, of course, the stays get a great deal better hold. The flanging of copper, of course, was a much easier matter than the flanging of steel, and the plates were not nearly so apt to crack in the corners where the flanging had been done.

In conclusion, the author stated that the initial cost of a copper fire-box was much higher than steel. The life cost, allowing for the value recovered on the scrap copper, of copper and steel was about equal. Copper sustains mechanical work better, and makes stronger and tighter joints than steel. It takes up sudden fluctuations in temperature more quickly and uniformly. Copper offers greater resistance to corrosion than steel. Therefore, engines fitted with copper fire-boxes should spend less time in shop directly consequent to fire-box trouble, and be less liable to failure on the road from leaking of stays and tubes and cracking of plates.—*Vulcan.*

The Expansion of Tube Ends in Stirling Boilers.—A report just issued by the Board of Trade on the failure of a watertube in a boiler of the Stirling type at the works of the United Alkali Company, at Fleetwood, England, on Jan. 13 last, calls attention to the desirability of the ends of tubes in boilers of this type being bell-mouthed as well as expanded into the drums to which the tubes are attached. For some time the Stirling Company have adopted the practice of bell-mouthing, and where tubes are not secured in this way there is a liability, as in the case under notice, for them to work loose under certain conditions of working, and to be forced out under ordinary steam pressure.

BOILER INSPECTION IN ENGLAND.

EARLY BOILER PRACTICE.

Towards the beginning of the present century stationary boilers were worked at pressures not usually exceeding 5 pounds per square inch.* They were crude pieces of workmanship, and makers of the period had little knowledge of the strength of material or the strains to which boilers were subjected when at work. From 1830 to 1840 the economic advantages of higher pressures were being realized, and pressures were being continuously increased. The general working pressure was then about 40 pounds, and although progress had been made in the design and construction of boilers, it did not keep pace with the advancing pressures. Explosions were, therefore, of frequent occurrence.

EARLY INSPECTING AGENCIES.

The first boiler inspecting company was established in 1854, and in 1859 the Vulcan Boiler & General Insurance Company (under the style of the Steam Boiler Assurance Company) commenced operations. This was the first undertaking which coupled boiler inspection with insurance, guaranteeing thus in business form a belief in the efficiency of inspection. The influence of the inspecting companies in improving boiler design was soon manifest, and many explosions doubtless prevented. A glance into the early records of the inspecting companies reveals an appalling ignorance. Boiler explosions in these days were considered unavoidable evils, the common impression being that a due attention to the water supply met all the requirements of safe working, while practices such as the wedging down of safety valves, etc., were matters of daily occurrence, and despite the exertions and influence of the inspection companies explosions were alarmingly prevalent.

PARLIAMENTARY INTERVENTION.

The attention of Parliament was directed to the matter, and in May, 1870, a select committee was appointed to inquire into the causes of steam boiler explosions. The late Mr. John Hick (M. P. for Bolton) was chairman, and the committee continued its labors until May, 1871. Much valuable evidence was taken, from which we note that there were then not fewer than 100,000 steam boilers in the United Kingdom, exclusive of boilers of locomotive engines and steamships, as well as those for domestic and hot-house purposes. The annual average number of explosions was fifty (one in every 2,000 boilers), resulting in the loss of seventy-five lives, and injuries to a much larger number of persons. The committee advised no drastic measures, being afraid that compulsory inspection would lessen the responsibility of the steam user; they made a few recommendations, however, and the labors of the committee were of good service in opening up the subject generally.

LEGISLATION.

The first actual step in Parliamentary legislation was the passing of the Boiler Explosions Act of 1882, and this again was extended in 1890. It requires that in the event of an explosion immediate notice be given to the Board of Trade, who send an inspector to make a *preliminary*, or, if necessary, a *formal* investigation into the circumstances. More recent legislation is of a provisional kind; the Quarries Act of 1894 empowers the mines inspectors to impose rules specially suited to the varying circumstances of the quarries under their super-

* Working pressures now commonly range from 80 to 100 pounds, and pressures of 160 to 200 pounds are by no means exceptional. The boiler of the Comet (the first passenger steamer in Europe, 1812,) was worked at 3 to 4 pounds, while the usual marine pressures are now from 160 to 180 pounds. The boiler of Stevenson's prize engine Rocket (Liverpool and Manchester Railway, 1829,) carried 50 pounds, but the working pressure of locomotive boilers now ranges from 160 to 200 pounds.

vision with a view to prevention of accidents. Under such rules the inspectors may require that each boiler be cleaned out and examined internally, so far as its construction will permit, by a competent person at least once every three months, and externally and internally by a competent engineer at least once in every twelve months, the result of such examinations being recorded and signed by the person who makes them in a book provided for the purpose.

LATER ACTION.

The Factories and Workshops Bill, enacted in 1901, specifies that a steam boiler used in a factory or workshop must have attached to it a proper safety valve, steam gage and water gage, which must be maintained in good condition, and the boiler must be cleaned out and examined internally by a competent person at least once in every three months and oftener if necessary, and be examined internally and externally by a competent engineer at least once in every twelve months. The person making an examination must forthwith enter in the general register a certificate signed by him containing the prescribed particulars of the result of the examination. There are penalties for non-compliance with this regulation.

EXPLOSION STATISTICS.

The Board of Trade, as is generally known, publish particulars of all boiler explosions under the acts of 1882 and 1890. The following figures, taken from one of the annual summaries of the Board of Trade, show the value of inspection. It may also be noted that the term "explosion," as defined by the Boiler Explosions Act, is employed in its most comprehensive sense.

	Number of Boilers, Approximately.	Explosions.	Lives Lost.	Persons Injured.
Boilers insured	90,000	11	1	6
Boilers not insured or inspected (roughly estimated)	80,000	42	32	60

INDEXING SYSTEM FOR BOILER AND PLATE METAL SHOPS COVERING BLUE PRINTS, TRACINGS AND PATTERNS—II.

BY EDWIN E. BOHRER.

SHOP BLUE PRINTS.

By this heading we refer to the prints that have been used in the construction work, and have, as it were, been "through the mill." These prints often have a surprising amount of value in duplicating a job, for the writer finds many times the layer-out has placed notes on same for his reference which may save him a good deal of time if he is called upon to make the lay-out again, and on the other hand this information is such that it would not have any particular place on the tracing. In short, we save our shop prints, sketches, etc., and want to be able to find them.

Each blue print, therefore, has the order number stamped on it when it leaves the drawing-room. We use for this a six-band numbering stamp; size of figures 5/8 inch. At the same time that we stamp the number on the prints we stamp the same number on the upper right-hand corner of a large envelope, size of these envelopes being 9 inches by 18 inches. Directly under the order number we write the purchaser's name, and give a very brief description of what is being made under this order number, and then give the blue print number of each print that has been sent to the shop. These envelopes are placed consecutively in a shelf, and when the prints covering, say, a month's work are returned, they are filed away in their respective envelopes, and then filed consecutively in their regular shelf. These shelves are sub-divided, each section containing about five hundred (500) envelopes. In this way they are easily found at any time when the order number is known.

In a case where a contract is duplicated the old prints are restamped with the new order number, and another envelope is written up the same as above described with an additional note giving the order number it is a duplicate of, and the old envelope is also marked, telling just what order number the prints were last used under. By keeping your old envelopes marked in this way in the case of a contract that is being duplicated several times a year, should you not get the last order number at first, you can refer back by means of your envelopes, and thus obtain same, and therefore find your prints in this way.

The material required for the above is very slight, as you only need the stamp and a stock of large envelopes. The additional time required in your drawing-room to fix up these envelopes would soon be gained when looking for old prints.

(To be concluded.)

TWO PROPOSED UNITS OF POWER.*

BY PROF. WILLIAM T. MAGRUDER.

James Watt is said to have defined a "horsepower" as 33,000 foot-pounds of work per minute, and a "boiler horsepower" as the evaporation of a cubic foot (62 pounds) of water per hour. His rule is sometimes put into the form that "1 square foot of grate surface, 1 square yard of heating surface, a half of a square yard of water surface, and 1 cubic yard of contents equals 1 horsepower, and will evaporate 1 cubic foot of water per hour in a waggon boiler."

Charles E. Emery, Charles T. Porter and Joseph Belknap, "Committee on Boiler Trials of the Judges of Group XX.," reported, through Horatio Allen, chairman of Group XX., to Prof. Francis A. Walker, Chief of Bureau of Awards of the United States Centennial Commission of the International Exhibition of 1876, that "the estimated horsepower of the several boilers" was given "on the basis that the evaporation of 30 pounds of water is required per horsepower per hour, the results being derived from evaporation at steam pressure of 70 pounds from temperature of 100 degrees."[1] In the Report of the Committee of Judges of Group 20, p. 131, as published by J. B. Lippincott & Company, Philadelphia, "the commercial horsepower of a boiler is fixed at 30 pounds of water evaporated at 70 pounds gage pressure from a temperature of 100 degrees."[2] It is to be noted that the time element is omitted. This is not an unusual mistake in speaking of rates, the time element being understood, or taken for granted. This definition is commonly modified so that the Centennial standard of horsepower or the "Centennial horsepower" is defined as the "evaporation of 30 pounds per hour of water at 100 degrees F. into dry steam at 70 pounds gage pressure, or the equivalent." This last phrase is very generally omitted. It is interesting to note that the committee called it the "commercial horsepower," and not a "boiler horsepower." They also defined the "unit of evaporation" as 1 pound of water at 212 degrees F. evaporated into steam of the same temperature, and as being equivalent to 965.7 heat units.

In the appendix is given a summary of the reports of committees of the society relating to horsepower units and of various discussions on the subject. From these it will be seen that while trying to keep to the Centennial standard of commercial (boiler) horsepower, the committees have gradually veered to the thermal unit standard, and from the standard of

* From a paper read before the American Society of Mechanical Engineers.

[1] United States International Exhibition, 1876. Reports and awards, Vol. 6, p. 426, Sec. 35.

[2] Trans. Am. Soc. M. E., Vol. 21, p. 84. Report of Committee on Revision of Standard Code.

30 pounds from 100 degrees F. into steam at 70 pounds gage pressure.

Since 1876 the accuracy of our knowledge of the heat of steam has increased. This is especially true since 1899, the time of the last report to the society. The "confusion to practical boiler owners," which Dr. Charles E. Emery seemed[3] to fear might result from the practice of measuring the power of a steam boiler in heat units, does not seem to have materialized.

The publication of the new eighth edition of Prof. Peabody's *Tables of the Properties of Steam*, and the publication of the *Tables and Diagrams of the Thermal Properties of Saturated and Superheated Steam*, by Profs. Marks and Davis, have complicated this matter still more, and especially with engineering students.

According to the steam tables of Charles T. Porter, and the various reports that have been referred to on this subject, the value of the "unit of evaporation" is 965.7 B. T. U. According to Peabody, its value has been gradually changing to 965.8, 966.3, and now to 969.7. According to Marks and Davis its value should be 970.4. These differences amount to only 4.7 B. T. U. in 970.4, or to one in 205, which is one-half of 1 percent. It would seem desirable to use 970 hereafter instead of 966 as the unit of evaporation, this being the average of the most accurate determinations of the latent heat of evaporation of water at 212 degrees F.

Similarly, the "unit of commercial evaporation" has been changing from 1110.2 B. T. U. in 1876 and 1884 to 1115.0 according to Peabody, and to 1115.6 B. T. U. according to Marks and Davis to-day.

When measured in thermal units the value of the boiler horsepower, 34½ units of evaporation, is given as 33,305 B. T. U by the Centennial judges and by the committee reporting to the society in 1884; as 33,317 B. T. U. in the report of the committee as made in 1899; as 33,320 B. T. U. in one text book on steam boilers; as 33,454.7 B. T. U. (34½ by 969.7) by Peabody, and as 33,478.8 B. T. U. (34½ by 970.4) by Marks and Davis.

TABLE I.—DIFFERENT VALUES OF A BOILER HORSEPOWER IN B. T. U.

	UNITS OF EVAPORATION.		UNITS OF COMMERCIAL EVAPORATION.		B. T. U.
	One.	34½.	One.	30.	
Centennial	965.7	33,317	1110.2	33,306	33,305
Peabody	969.7	33,455	1115.0	33,450	......
Marks and Davis	970.4	33,479	1115.6	33,468	......

It must be evident to everyone that a would-be standard which has so many different thermal values and is capable of acquiring others with each change in the steam tables is not only indefinite but confusing. It is not a definite unit of measurement, which all standards should be. It seems a pity that in the definition of such a commonly-used engineering term there should be any possible chance for confusion and misunderstanding on the part of the student, or for litigation between contractors over the accuracy of the fulfillment of the terms of the contract.

Again, for over thirty years, engineers and engineering teachers have been apologizing for the use of the term "boiler horsepower." Even the committee of the society which reported in 1884 says:[4] "It cannot properly be said that we have any natural unit of power for rating steam boilers." If a horsepower is the rate of doing work, and a boiler is considered as a machine, and the water as the moving parts, the only mechanical power that a boiler produces is that due to the external latent heat of evaporation, except when it explodes. Hence the term "boiler horsepower" is a misnomer. The object of the use of a boiler is the absorption of the heat energy obtained from the potential energy of the fuel by combustion, and the transfer to and storage of the same by a volatile liquid for convenient use in a heat engine, or for other thermal purposes. Hence as a boiler uses the latent heat energy of the fuel as its source of supply, and develops and delivers available heat energy, there would seem to be every reason why the power or ability of a boiler to deliver energy should be measured in thermal units, as being the only unit of energy that the boiler ever normally receives or delivers. Furthermore, the energy from every boiler is always measured in heat units before being reduced to boiler horsepower.

To measure the capacity or power of a boiler plant, or its output of energy, in millions of thermal units would not be practical; a smaller unit is desirable. It is therefore proposed to measure the power or capacity of a boiler in "boiler powers," and to define a boiler power as 33,000 B. T. U. of heat energy delivered per hour by a steam boiler, steam main, or by a hot-water heating main, or the like, or added per hour to the feed water of a boiler, or to the water of a hot-water heating system. The acceptance of this term will, it is thought, simplify the whole subject; the unit will remain constant, will be easily remembered and easily used, and will not be one of three standards, differing slightly among themselves, as is at present the case with the term boiler horsepower. Its analogy to mechanical horsepower will be helpful rather than the opposite, especially to the beginner in engineering knowledge. The unit boiler horsepower may still be retained by those who may prefer to use it in some one of its many thermal values.

The rapid introduction of gas engines using blast furnace, coke oven, or producer gas, leads to the suggestion of a new unit for the capacity or power of a gas producer, coke oven or blast furnace to deliver available heat energy for use in gas engines, under stoves and boilers, or for other thermal uses.

At the St. Louis meeting of the American Association for the Advancement of Science in December, 1903, the writer read a paper suggesting the term "producer horsepower" as a unit. Since then the question has arisen as to why the old misnomer of "horsepower" should be perpetuated as a unit of measurement of heat energy. Why not simplify and shorten the term "producer horsepower" to "producer power"? If such a unit is desirable for the measurement of the capacity or power of a gas producer, why not suggest similar ones for other generators of heat energy available for use in gas engines and for other thermal uses? Instead of measuring the power of a gas producer in producer powers, and the powers of a blast furnace and of a coke oven to generate heat energy in blast-furnace powers and coke-oven powers, it is proposed to include all such sources of power, and to measure the heat energies of gaseous and liquid fuels in "gas powers," and to define a gas-power to be 10,000 B. T. U. of heat energy delivered per hour by a gaseous or liquid fuel. The calorific value should be measured from and to 62 degrees F. and at 30 inches of mercury. This unit can be applied and used in the measurement of the energy delivered by a gas well, a gas main, a gas producer, a blast furnace, a coke oven, an oil well or a pipe line.

The number 10,000 B. T. U. has been chosen as the average in the best gas-engine practice to-day of heat energy required to develop a horsepower of mechanical energy. The figure bears to current gas-engine practice about the same relation that 30 pounds per hour of steam at 70 pounds gage pressure from water at 100 degrees F. did to current steam-engine practice in 1876. The definition as given contemplates using only the higher calorific value of the fuel, rather than the lower or, so-called, effective value.

[3] Trans. Am. Soc. M. E., Vol. 6, p. 334. Report of Committee on Revision of Standard Code.

[4] Trans. Am. Soc. M. E., Vol. 6, p. 263. Report of Committee on Revision of Standard Code.

It is to be hoped that some such unit for the measurement of the output of a generator of heat energy in gaseous or liquid form can be found, and adopted by common consent, before practice and commercial custom in different portions of the country shall have learned to use units which have been less carefully selected and less accurately defined.

THE MAINTENANCE, CARE AND UPKEEP OF PNEUMATIC HAMMERS.

BY GEORGE H. HAYES.

Having been connected for a number of years with the manufacturing end of the largest pneumatic tool company in the world, I have been asked to write a few words concerning the maintenance of pneumatic hammers and the abuses which they receive at the hands of the men on the job. The material used in the construction of pneumatic hammers is the very best that money can buy, and is the result of long periods of experimenting at an outlay of a great deal of time and money to get material that is best able to withstand the vibrations, jar and wear which pneumatic tools are called upon to withstand. The treating of the material, fitting up and testing must be done by experienced and competent men. Pneumatic tools are made with the most extreme care, the moving parts are accurately and closely fitted, and when the proper lubrication is neglected, which is the most unpardonable offense to which a piece of fine machinery can be subjected, the moving parts of a pneumatic hammer will wear rapidly and in a very short time refuse to work.

Another source of trouble is sometimes located in the pipe line. Moisture carried in the air will rust the pipes, and if a hammer is connected up without first blowing out the pipes a sediment is liable to be blown through into the tool, causing the valve or piston to stick. Rubber deteriorates very fast, and particles of the hose may blow into the valve box and stop up some of the parts. Many times we have had hammers that would not operate sent into the factory, and on dismantling them found the port holes plugged up with pieces of rubber or sediment from pipes, which when thoroughly washed out with gasoline, reassembled and properly oiled, would operate perfectly.

Another abuse is practiced in taking a hammer apart and putting it together again. Some repair men, instead of using a wrench or soft hammer in loosening or tightening the handle, use a hard steel hammer, battering the parts badly, and in many instances breaking them. The finished parts should never be struck with anything but lead or copper hammers, and even when this is done, good judgment should be used as to the strain put on the threads of the handle and the cylinder.

There are many abuses practiced in connection with the operation of pneumatic hammers which are hard to locate, one of the most flagrant being the use of short pistons in riveting hammers. The manufacturers, after long and careful experimenting, have decided on a piston of proper length to perform satisfactorily the work for which the tool was designed, and all parts are made in proportion to withstand the strain. Workmen who are anxious to perform their day's task in the shortest possible time, or to increase their volume of work where they work on a per-piece basis, have little or no regard for these labor-saving devices. Having discovered that a piston a fraction of an inch short will do the work more rapidly, they resort to all manner of means to secure them, even having them made in outside machine shops. They carry them in their pockets, and when they take a hammer from the tool room they substitute the short piston for the one of proper length, again making the exchange before returning the hammer to the tool room. The result is, sets and handles are broken and cylinders frequently split. With these breakages occurring at short intervals, it would be well to detail someone to go through the shop and examine the pistons while the hammers are in use, otherwise the cause of the breakages will not be definitely located.

Some of the large plants using pneumatic tools have adopted the practice of issuing a given tool to the same workman continually, which has had a tendency to cause better care to be taken of the tools. If breakdowns occur frequently, it enables them to compare the amount of work being accomplished by different tools, and the more careless workmen are located and disciplined. Where this practice is followed, many times when the output of the shop is being forced to such an extent as to require all tools in service, and a workman is delayed in completing his work, while the men who are more careful of their tools finish in good time, it has a tendency to cause others to exercise greater care, which accrues to the benefit of all parties interested, even back to the manufacturer.

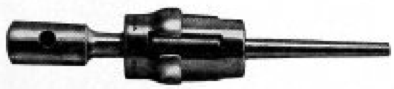
A great majority of men who operate pneumatic hammers in the shops know very little, if anything, about the construction of the tools, and it pays any large institution using pneumatic tools to employ a competent man to look after them, see that they are properly lubricated and returned for cleaning when through with their work. I have been in foundries using large numbers of hammers in cleaning and chipping castings where at the sound of the whistle the hammers would be thrown down, generally in the sand, and enough sand or grit would get into the tool so that when the air was again turned on the piston would stick fast after one or two blows. This necessitates a cleaning of the tool, causing a loss of time in its use of from twenty to thirty minutes.

In starting to drive rivets in cold weather, especially on structural or out-of-door work, the hammer should be warmed up enough to take the frost out of the steel, as a hard piece of steel full of frost is liable to break at the first blow; after a few rivets have been driven, there will be enough heat from the rivets to keep the frost out. On the other hand, never allow the temper in the rivet set to be drawn too low, as a soft set will break very quickly. When driving rivets rapidly, have a pail of water handy and put the set and end of the hammer cylinder in the water occasionally to keep from drawing the temper, or change the set occasionally.

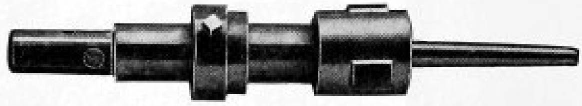
The wearing of parts in a hammer will always take place, but the life of the tool can be prolonged greatly by proper care and attention. Crystallization of the steel takes place owing to the rapid blows of the piston and the vibration. The life of the hammer depends mostly on the care which it receives and the character of the work being performed with it. A piece of fine machinery such as a permanent hammer can be ruined in a few minutes by ill usage and neglect.

It has been proved conclusively during the past few years, that pneumatic tools are invaluable in shop practice wherein they are adaptable. Either a small or a large installation of pneumatic equipment is the most economical in maintenance cost. The small installation does not require a special attendant, but can be looked after by the regular mechanical force, reducing the labor charge to a minimum. With an equipment consisting of forty tools or more, it should be put in charge of a special machinist, whose duty it is to follow the equipment closely and to keep it in good repair. It has been clearly proved that one man can care for 100 tools where the proper attention is given by the men handling them. We have recently had our attention directed to tools in service which have been working regularly for a period of seven years. These tools, of course, have been well cared for, and the workmen using them appreciate their value in aiding them in their labors and handle them as they should be handled.

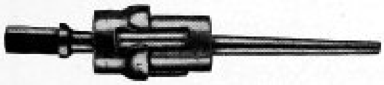
Pneumatic tools are outrageously abused in many cases without the knowledge of the management, and at other times with



"Boss" Roller Expander (Hand Use)

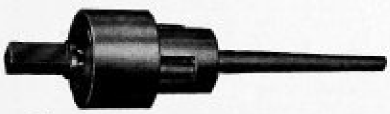


Arch Flue Expander



Boss" Roller Expander (Self-Feeder)

Universal Expander (Hand Use)



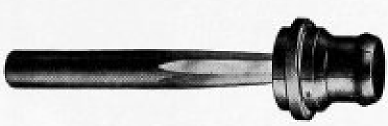
Universal Expander (Self-Feeder)

Removable Collar Expander (Hand Use)

Removable Collar Expander (Self-Feeder)

Rapid Beading Expander

Rapid Beader Tool



Improved Sectional Expander

FAESSLER

BOILER MAKERS' TOOLS

ARE STEEL THROUGHOUT

This strong point is but one of many that skilled boiler makers invariably recognize in Faessler Tools.

Space here does not permit describing each in detail. If it did, we think we could easily convince you beforehand of the ability of any Faessler tool to withstand the hardest knocks of severe service and do first-class work under trying conditions.

But better than this, we want you to see for yourself in your own shop that our claims are not exaggerated. Tell us the size and kind of tools needed, and we will supply your wants on condition that our tools must prove highly satisfactory in every way or may be returned at the end of a 30-days' trial.

TRADE MARK BOSS REGISTERED

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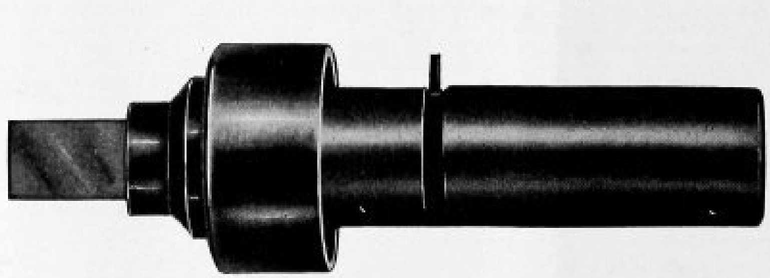

"Perfect" Flue Cutter

their sanction, the latter being on account of these tools having such a large earning power that they are considered an economical investment even though their life be but three months. This latter remark may seem an exaggeration; however, it is borne out by actual knowledge. One of the largest steel concerns in the world is using chipping hammers where nine hammers in the hands of men skilled in their operation easily perform work which would require ninety unskilled men with mauls and cutters. The tools in this case are appreciated by both the management and the workmen, and are well cared for. Even when the tools have a short life, a great many concerns having adopted them state that the saving in wages and increased output make them an extremely economical investment.

Modern labor-saving machines are sometimes blamed for lowering the standard of skilled workmen by transferring him into a mere automatom—a droning machine tender. Undoubtedly in some crafts there is less call for men of manual dexterity than there was before the invention of labor-saving devices, leading to a decreased demand for all-around mechanics and an increased demand for men of only sufficient intelligence to guide an almost sentient machine. On the other hand, many types of labor-saving devices have counteracted this tendency by offering mechanical means for doing the drudgery of a shop, making necessary a higher average of intelligence than before. Pneumatic hammers and drills, portable electric drills and hydraulic riveters are in this class, as skill and judgment rather than mere brute strength and endurance are called for in their operation.—*Machinery.*

The Illinois Central has 1,400 locomotives, and all have been equipped with new ash pans in conformity with the law passed by Congress on May 30, 1908. Some of the smaller roads have found it impossible to comply with the law in the given time, and have asked for an extension of time.

THE CREWE WORKS OF THE LONDON AND NORTHWESTERN RAILWAY COMPANY.

A recent issue of *The Engineer* contains a large and handsomely illustrated supplement describing the history of the London & Northwestern Railway and also of the Crewe Works, from which the following is taken:

The Crewe Works were established in 1843. They were originally built with the object of repairing locomotives, carriages and wagons for working the Grand Junction Railway, now a part of the London & Northwestern system. The portion of the works at that time devoted to the use of the locomotive department soon became inadequate to maintain the locomotive stock effectively, and additional accommodation had to be provided by the removal of the wagon department to Ordsallane, Manchester. In 1853 a further addition was made to the Crewe establishment by the erection of works for the manufacture of rails. In 1857 an amalgamation of the northern and northeastern division of the line was effected, and the works at Crewe became the center of the locomotive and carriage departments of the northern division. So fast was the company's stock growing that in 1859 further accommodation for the locomotive department was required at Crewe, and this was obtained by the removal of the carriage department to Saltley, Birmingham. In 1862 it was deemed advisable to combine the locomotive departments of the northern and southern divisions, and additional accommodation was provided at Crewe by the erection of suitable work shops. A very important addition to the Crewe establishment followed in 1864, when works for the manufacture of Bessemer steel were erected.

In 1870, to keep pace with the additional development of the line, a new boiler shop and smithy were built at the steel works. In 1874 the tender building and repairing shop and the engine

FIG. 1.—GENERAL VIEW OF THE BOILER SHOP AT THE CREWE WORKS

painting shop were removed to larger premises at the steel works.

Although the works are chiefly engaged in the building of locomotives they also produce a large quantity of warehouse machinery and other general machine work, such as is used at the stations.

At the present time the Crewe works give employment to 7,700 persons, and to these may be added over 700 engine drivers, firemen and others at the steam shed at the Crewe station. The company has built and owns 845 workmen's cottages; manufactures and supplies gas not only to the works but to the whole of Crewe and supplies water to the works in town.

The ground upon which the works stands is about 1½ miles long, and its area is 137 acres, of which 48 acres are covered with buildings. The works are adjacent to Crewe station, the most important junction on the company's system, and are divided into three main groups, known as the old works, the deviation works and the steel works. It is said to be one of the largest locomotive works in the world.

The general offices are placed nearly central with the entire establishment; they are placed with the front facing towards the works. The façade of the building is 525 feet long and slightly curved. On the ground floor are the offices of Mr. George Whale, the chief mechanical engineer and locomotive superintendent; the manager of the works, the running department, the signal and electrical departments, out-station department and the drawing office, which is 200 feet long by 30 feet wide. The offices, as well as many of the shops, are lighted throughout by electricity, incandescent lamps being used in the offices and arc lights in the shops. A complete telephonic system connects the offices and the whole of the shops; a fire main with water at a pressure of 100 pounds per square inch is provided in that portion of the works where most of the inflammable materials are handled. There are in addition two mains for supplying hydraulic pressure to the machinery in the steel works, one at 400 pounds pressure and the other at 2,000 pounds pressure. Steam is supplied to the engines in the steel works by sixteen stationary boilers, 30 feet by 7 feet, and by twenty-four boilers of the locomotive stationary pattern, the former working at a pressure of 80 pounds and the latter at 100 pounds pressure, and all the boilers are built of Crewe steel at the Crewe works. Each of the three main sections has an adjacent power station, in which electric current is generated and distributed by overhead cables to the different shops. The various parts of the works are connected by a railway, 4 feet 8½ inches gage, and there is in addition a narrow gage line (18 inches gage) traversing nearly every part and of a total length of about 5 miles. The latter is worked by small locomotives and handy light steel trolleys for moving materials.

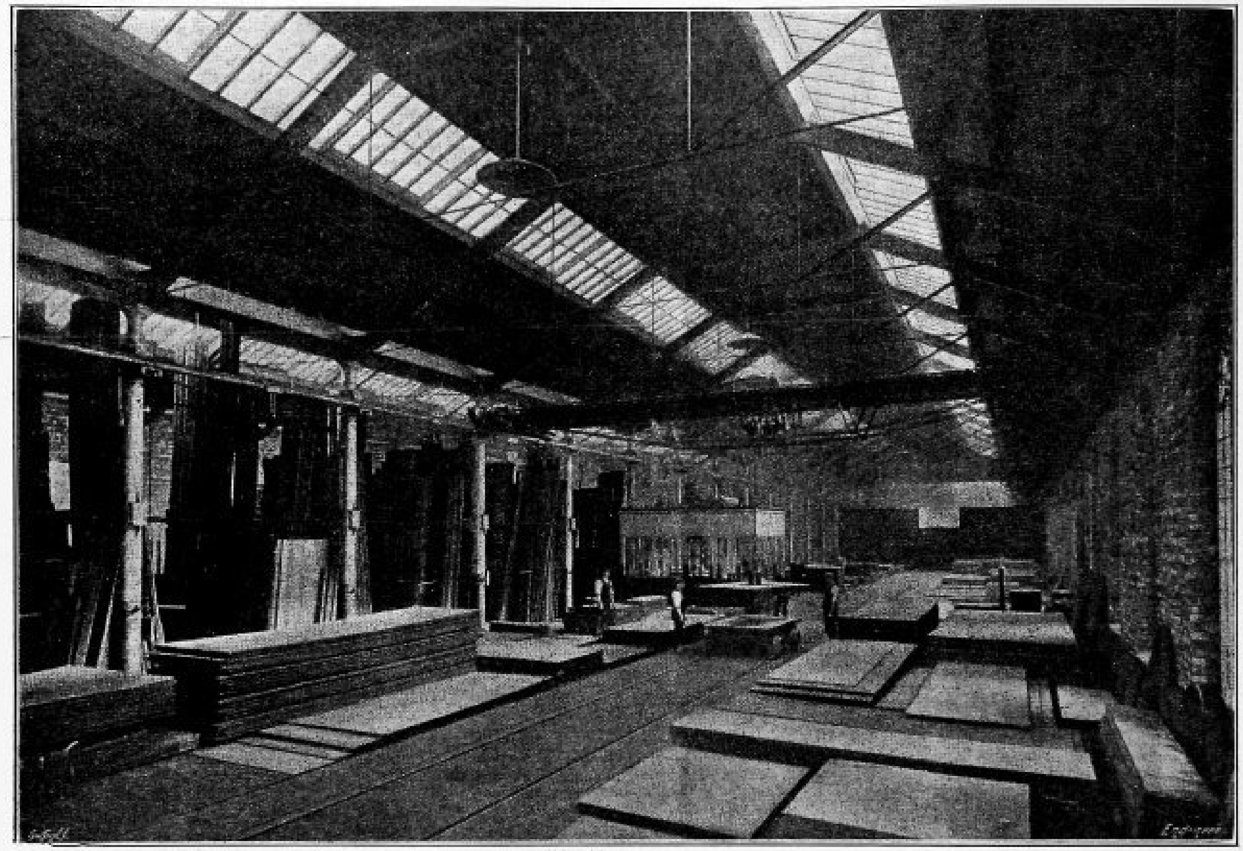

FIG. 2.—PLATE STORES.

The boiler shop, Fig. 1, which is of particular interest to our readers, measures 673 feet by 107 feet 6 inches. It is equipped with appliances sufficient for building about 200 boilers and doing the necessary repair work for the boilers of 3,000 engines per annum. Owing to the increase in the size of locomotive boilers in recent years, the roof of a portion of this shop has had to be raised to enable boilers to be hung in a vertical position by 15-ton cranes for the operation of a hydraulic gap riveter. It should be mentioned that nearly all riveting is done by fixed or portable hydraulic machinery. Besides the crane already alluded to the shop is also provided with four 10-ton electric cranes. The shop is well equipped with large rotary drills, shearing, forging, tapping and pneumatic calking tools and plate-bending rolls. After being built in this shop each boiler is taken to a testing station in close proximity, and is

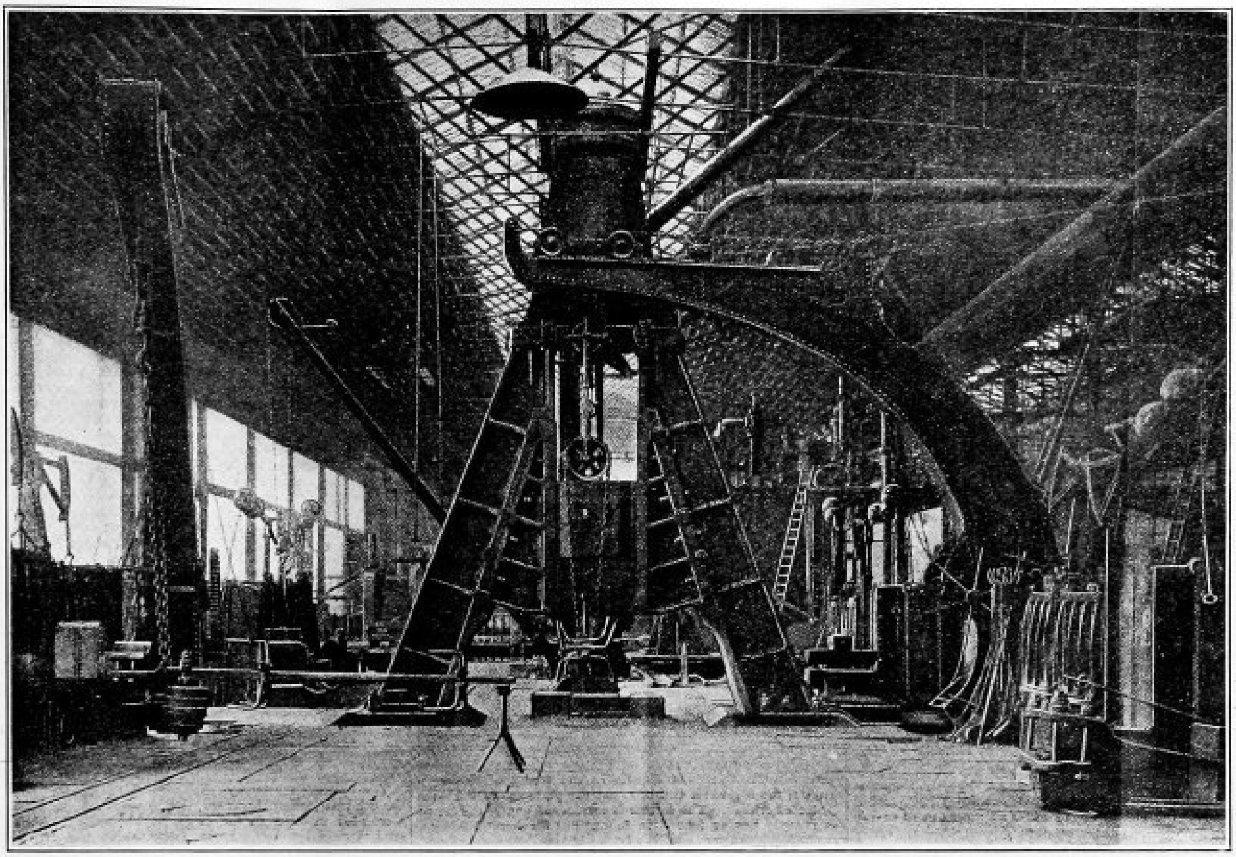

FIG. 3.—EIGHT-TON STEAM HAMMER.

subjected to a steam test of half the ultimate working pressure. After successfully passing this test the boilers are submitted to a hydraulic test, the pressure being one-third in excess of

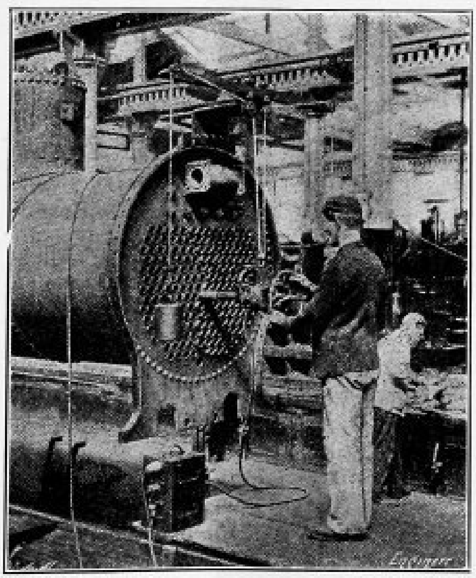

FIG. 4.—BOILER TUBE CUTTER.

the ultimate working pressure. In order to make assurance doubly sure a final test is carried out under steam at 5 pounds in excess of the working pressure.

In addition to the purely locomotive work numbers of stationary and other boilers required for the company's use are built and repaired. Steel girders, both plate and lattice, for warehouses, foot bridges, etc., are also produced in this shop. As an instance of what can be accomplished in a short time, it may be mentioned that forty-two girders, each 32 feet long, were produced from the raw material in seven days to replace the Llandulas Viaduct on the Holyhead Line, which was washed away by a storm in 1879.

It is impossible to allude to all of the machine tools in this

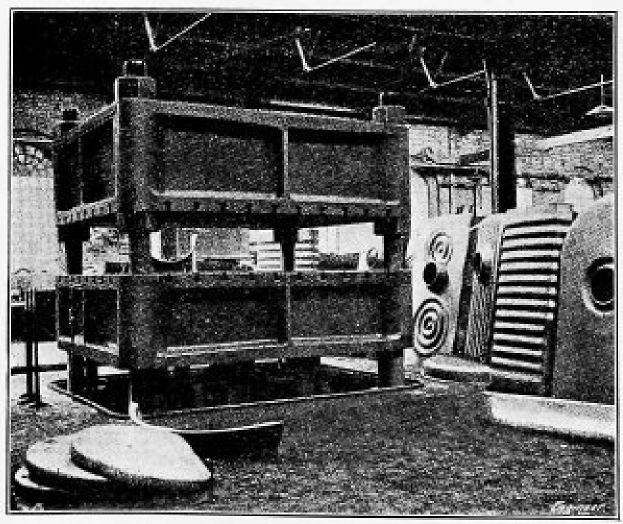

FIG. 5.—FLANGING PRESS.

shop, but Buckton's multiple drill for boiler end plates and a milling machine, by Beyer, Peacock & Company, for trimming off the corners of copper fire-boxes are both worthy of mention.

The flanging shop adjoins the boiler shop, and contains some massive hydraulic machinery. Among the appliances are three punching and flanging presses, by Fielding & Platt, with rams up to 2 feet 6 inches diameter and working at a pressure of 2,000 pounds. In these presses, one of which is illustrated, Fig. 5, steel fire-boxes, 6 feet 6 inches by 4 feet, can be flanged at one operation. The total pressure exerted by this press is 650 tons. All locomotive tube and other plates are flanged by hydraulic process in this department, and the plates are heated in two gas furnaces. The angle-iron smithy also adjoins the boiler shop. In this shop all the forging and stamping operations required for the work of this and other departments are carried out. The shop contains three steam hammers of 7, 15 and 30 cwt., a steam welding machine, hot saw and sixty smith's hearths.

THE CENTENNIAL OF THE FIRST ROLLING OF BOILER PLATE IN THE UNITED STATES.*

A double centennial celebration was held at Coatesville, Pa., on Saturday, July 2, commemorating the occupation of the present site of the Lukens Iron & Steel Company's works on the Brandywine Creek by Isaac Pennock, the founder of the Lukens plant, on July 2, 1810, and celebrating the making of the first boiler plate in America, in the old Brandywine Mill, under the direction of the forefathers of the present operators of the Lukens works. The occasion was also made noteworthy by the marking of the site of what has been known as the "Old Mill" with a bronze tablet, placed by the Chester County Historical Society.

The out of town guests were met by automobiles on the arrival of the various trains and taken to the offices of the Lukens Iron & Steel Company, where they were informally welcomed. Later luncheon was served on the lawn of "Gray Stone," the residence of President A. F. Lukens. At 2 o'clock a parade of the employees of the Lukens works was formed, which passed in review before the officers of the company and assembled guests, thence passing through the principal streets of the town and marching to a meadow on the banks of the Brandywine, near the Lukens works. Here the exercises of the afternoon were held, under the direction of George Morris Philips, president of the Historical Society. After Charles Lukens Huston had invoked divine blessing an address of welcome was made by Dr. Philips. He referred to the way in which the Chester County Historical Society, which had prepared the tablet for the site of the old Lukens mill, was performing similar service at other historic spots in Chester County.

Dr. Philips introduced John Fritz, who responded with reminiscences of the iron industry. Mr. Fritz said in part:

"The reputation of the Lukens firm was thoroughly established many, many years before my connection with the iron business; but there is one unparralleled and pleasant feature in this record—the length of time the works have remained in one family.

EARLY EXPERIENCES WITH PUDDLE MILLS.

"The first puddling furnace in this country was built at Plumsock, near Brownsville, Fayette County, Pa., in 1817. On Redstone Creek, in 1817, a flood caused its partial destruction and the machinery was subsequently removed to Brownsville. In 1819 a rolling mill was built at Pittsburg, containing four puddling furnaces. This was accidentally blown up and the machinery was taken to Covington, Ky. Both enterprises thus seem to have ended in disastrous failures. From 1817 to 1836 but little progress was made in the way of marked improvement. In the years 1844-1845 the manufacture of rails commenced. This at once gave puddling the leading position in the manufacture of iron, which it maintained until the introduction of the Bessemer process.

"At this time the manufacturers' troubles began. The demand for puddlers soon exceeded the supply and they thought it might be well for them to have things their own way. Hence the troubles commenced, and bitter they were. At that time the Welsh hammer was the only way in use to put the puddled ball in shape for the rolls. Then the crocodile squeezer came into use, next the Winslow squeezer. All of them were incapable of doing the work properly and in quantity. Next and last came the Burden squeezer, the introduction of which caused the bitterest strike I ever witnessed. As I at this time recollect there was but one Burden squeezer put in that did not cause a strike. This was at Cambria, and there was a little strategy practiced which at that time was highly essential.

"After a time the puddlers became reconciled to the use of the squeezer and it came into general use, and is to this day as nearly perfect a machine for the purpose intended as has been devised. It is simple in its construction, does its work in a perfect manner and establishes justice between the ironmaster and the workman from which there is no appeal, and, in the end, it became the puddler's friend.

"About the year 1848 boiling came into general use. This was a great improvement, and puddling soon became the all-important branch of the great iron industry of the country and continued in the lead until it was overtaken by the almost magical invention of Sir Henry Bessemer.

EARLY BLAST FURNACE PRACTICE.

"Until about the year 1840, practically speaking all the iron product of the United States was made with charcoal. My first conection with the blast furnace was in 1839. It was set against the hills so that the ore, charcoal and limestone could be delivered on a level with the tunnel head to save hoisting. The blast was made by water power, the blowing cylinder was made of wood, and was driven by a wooden beam, which was connected to the crank on the end of the water wheel shaft by a connecting rod. I was sent to this furnace as a cub to put up what was called a belly pipe, which was made at the shop. I was learning my trade. When it was put in place it did not reach the tuyere by some 6 or 7 inches, and I suppose some mistake had been made in the length. The man in charge, founder as he was called, opened his hand and placed his thumb at the end of the pipe and opened his finger at the opening for the tuyere and said it was just right. The pipe was connected to the main pipe by a short leather connection so it could be swung out of the way to get the cinder out. The general condition of the furnaces was very crude until 1840, when David Thomas, since affectionately called "Father Thomas," made the first anthracite iron in a commercial way that was made in this country.

THE EVOLUTION OF THE ROLLING MILL.

"In 1824 the rolling mills were in a very crude condition and there was no marked improvement in them until the manufacture of rails commenced. But even at this time the plan of the mills and the manner of buliding them practically remained the same. The mills were geared. The general impression of the rolling mill proprietors seemed to be the more wheels they could get in the better the mill. Up to this time the carpenter or millwright had largely to say; con-

* As reported in The Iron Age of July 7, 1910.

sequently wood was much used, the shafts were generally made square and the flywheel and the gear wheels were secured on them by wooden wedges into which thin wedges of iron were driven. After the manufacture of rails commenced, a more rigid and better workmanship was required. The millwright and carpenter were superseded by the machinist; the shafts were now turned up and the wheels bored out and the mill all fitted in a more workmanlike manner.

"From 1845 to 1856, there were but few improvements made either in machinery or in the manner of rolling except in the introduction of the rail straightening machine, which took the place of the 60-pound sledge and a special man to handle it. When he wanted to rest the works came to a standstill until such time as he was completely rested, sobered up or restored to health, as the case might be.

INTRODUCTION OF THE THREE-HIGH MILL.

"The year 1857 is a memorable period in the history of the manufacture of iron. Up to this time all the rails were rolled on a two-high mill, a most crude and unscientific manner of rolling iron, especially rails, they being passed back over the rolls, the metal cooling, and as the rail was formed the flange became thinner and cooled more rapidly, and consequently it was much more liable to crack and tear up. In the three-high mill the tendency to crack or tear the flanges is greatly reduced from the fact that in passing through the rolls in the opposite direction, any crack or tear that may occur is rolled down instead of being increased as in the two-high mill, in which it frequently happened that the flange tore off the whole length of the rail, winding around the roll and forming what was called a collar, and at times breaking the roll. Besides the greatly increased quantity that could be made in a given time, the quality was greatly improved and the criminal practice of patching rails, which were liable to break in the track, killing people, destroying property and delaying traffic, was completely abandoned. This alone in the days of iron rails made the improvement invaluable. But the traveling people at large knew nothing of the danger they were constantly exposed to when on a train.

THE NATION'S GREAT DEBT TO BESSEMER STEEL.

"The Hon. Abram S. Hewitt, in replying to the presentation to him in 1890 of the Bessemer medal by the Iron and Steel Institute of Great Britain, speaking on the Bessemer process, stated that a striking effect of this invention was that it furnished us the means of paying off our national debt. He showed that the cheapening in the cost of transportation enabled us to increase enormously the sales of food products in foreign markets, and our imports of foreign merchandise were correspondingly increased. From these imports a revenue was derived enabling the country to reduce the national debt in 25 years from about four thousand millions of dollars to less than nine hundred millions of dollars in 1890.

"When I was a boy of ten years old, I read a speech made by Thomas F. Benton of Missouri, in which he said that if he had his way he would build a great national highway from the Atlantic to the Pacific oceans, and on the highest peak of the Rocky Mountains he would erect a colossal statue of Christopher Columbus, with the right hand extended as if saying, 'There is the way to India.' As I grew up and railroads came into general use, I belived it would be practicable to build one across the mountains, but I did not expect to make the rails for it, which I did, and it was the introduction of steel rails that made it possible. Now I have lived to see five or six transcontinental lines built and we are trying to get more. Were they to undertake to build a railroad from the Atlantic to the Pacific and start at the Atlantic end, using iron rails such as used to be made, and using 150-ton locomotives and cars carrying 50 tons of freight, the rails on the Atlantic end of the line would be worn out before the Pacific would be reached.

"It is to the invention, introduction and perfection of the modern system of steelmaking in this country that we are indebted for the education of our people in the scientific, mechanical and metallurgical arts, enabling them to erect such manufacturing plants as were necessary to supply our Government with the sinews of war, and thus making it possible to achieve those glorious victories which at once placed us in the front rank among the nations of the earth."

HISTORY OF THE COMPANY AND OF IRON MAKING IN CHESTER COUNTY.

A. F. Huston, president of the Lukens Iron & Steel Company, followed with an address, reviewing the history of the company from the time its founder, Isaac Pennock, established the Federal Slitting Mill at Rokeby, on Buck River, Chester County, in 1780, to the erection of what was known as "the Old Mill" on the Brandywine Creek, the site of the present Lukens plant, in 1810, and the development of the same in later years.

Ex-Governor Samuel W. Pennypacker, president of the Historical Society of the State of Pennsylvania, made an interesting address on "The Early Iron Industry in Chester County." He said that early iron making in Pennsylvania began along the Schuylkill River. The first authentic manufacture was in 1717, when Rutter & Potts began the manufacture at Colebrookdale. In 1718 Samuel Matt established the Coventry Forge in Chester County, so that the county ranks second in the manufacture of iron in Eastern Pennsylvania. In 1736 iron making was engaged in at Pottstown at Warwick Furnace, where many of the early stoves were made. Here also were cast cannon and balls for use in the Revolutionary War. About 1740 an iron plant was located at Valley Forge, on the Schuylkill River, operated originally under the name Mount Joy Forge, but later changed to the Valley Forge, from which that historic locality takes its name.

The speaker referred particularly to the elaborate ornamentations on iron implements and castings in the early days. While the castings and tools were crude in manufacture the ornamentation was quite artistic. Steel making was engaged in at Coventry at a much earlier date than that claimed for its manufacture in Connecticut.

Congressman Thomas S. Butler followed with a brief address congratulating the Lukens management on its long and successful career, and wished it continued success.

At the close of Congressman Butler's address the assembled guests proceeded to the Chemical Laboratory of the Lukens Works, which stands on the site of the old mill. On a granite column against this building the bronze tablet commemorating the making of boiler plate was placed. After brief remarks by Dr. Philips the unveiling of the tablet was performed by Charles Lukens Huston, Jr., son of C. L. Huston, vice-president of the company. With this came to a conclusion the exercises of the day. Visitors were then given an opportunity to visit and inspect the various departments of the plant.

Boiler Manufacturers' Convention.

The twenty-second annual convention of the American Boiler Manufacturers' Association will be held in Chicago, Ill., Oct. 10, 11, 12 and 13, with headquarters at the Auditorium Hotel. Rates for rooms will be as follows: $2.00 per day and up, single, without bath; $3.00 per day and up, double, without bath; $3.50 per day and up, single, with bath; $5.00 per day and up, double, with bath.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

The Welfare of Boiler Makers.

One of our readers has sent us a list of questions relating to the standing of boiler makers among other mechanics. These questions are suggestive, and undoubtedly our readers will be willing to comment on them freely. The first is: Why is a boiler maker considered a competent man as regards the construction of new boilers and repairs to old boilers but incompetent when it comes to the attaching of mountings, such as feed pipes, blow-offs, safety valves, steam and water gages, etc., and also why is he considered incompetent when it comes to the testing and erecting of boilers in place? The second question is, why is a machinist generally considered a better man than a boiler maker for testing or inspecting boilers? and the third, why are the higher positions in mechanical trades filled by machinists while boiler makers are found so very seldom in these positions?

Assuming that the conditions implied by the above questions are true, our correspondent concludes that one must regard a boiler maker as "strong of back and weak of brains," and that the opposite is the case with the machinist. Finally, he suggests that it is time for the boiler makers to wake up and do something to impress upon the mechanical world their ability as mechanics and their fitness to handle every phase of work pertaining to steam boilers, including the construction, repair, erection, testing, inspection, etc.

We have no doubt that many other boiler makers have found the same condition existing as outlined above when seeking advancement to higher positions in the mechanical trades, or when seeking to increase their sphere of usefulness by attempting work outside of the construction and repair of boilers and sheet metal work. Taken individually, there is no reason why a boiler maker should be discriminated against in this way, provided he is competent to fill the higher positions. This cannot be said of every boiler maker, however, and fortunately, or unfortunately, any mechanic is influenced to a certain extent by the reputation which his fellow tradesmen have as a class. If a certain class of mechanics is known to be competent, intelligent and resourceful, and if it is known that the majority of men engaged in the trade are progressive and ambitious, everyone engaged in the same work enjoys to a certain degree the advantage of this reputation; whereas, if the workmen as a class are reputed to lack a broad mechanical training, although they may be considered thoroughly efficient for certain specific tasks which they are accustomed to perform, yet they would not be considered properly qualified to engage in a broader line of work unless there was ample proof that they could perform it successfully. This feeling is but natural on the part of employers, and the only way in which it can be overcome by any class of workmen is to establish such a reputation for skill, thorough training and competence as a class that they will be looked upon as leaders rather than followers.

Such a reputation can only be gained by the united efforts of the majority of men engaged in that particular line of work. Each one must feel that he is personally responsible for the general reputation of his profession or trade, and that by every act of indifference or incompetence he not only damages that reputation and injures hundreds of his fellow workmen but also directly injures his own chances in the world. We are inclined to believe that boiler makers are their own worst enemies in this respect; for no one doubts that the mechanical training received by a boiler maker, if he acquires both a practical and a theoretical training, is such as to fit him for the higher and broader positions in the mechanical world. There are any number of men engaged in boiler making whom we could name who are not only first-class mechanics but who have a thorough and intimate knowledge of the essentials of steam boiler operation and management, who are well versed in the groundwork of steam engineering, and who personally have every qualification not only to construct and repair boilers, but also to carry out the erection, testing, inspection, installation of fittings, and, in fact, design the entire boiler plant if necessary, but these are men who when they went into boiler making realized that they were entering an honorable and remunerative career—one in which there were problems to be solved which require not only practical but extensive theoretical knowledge, and, bearing this in mind, they sought and grasped every opportunity to secure the best mechanical training and education possible, so that they would be fitted to attack any of the many different lines of work open to them. What is needed to-day more than anything else is more men like these, and, as our correspondent suggests, it certainly is time that boiler makers as a class came to a realization of their responsibilities and did something to impress upon the mechanical world their ability and fitness to handle every phase of boiler making.

PERSONAL.

Joe Holloway, who has been engaged in general boiler work at San Bernardino, Cal., has taken the position of engineer for the Bonner Fruit Company, Lankershim, Cal.

R. C. Sermon has resigned as manager of the National Boiler Works, Hibbing, Minn., to take the position of master boiler maker for the D. R. T. & W. R. R., Virginia, Minn.

Lee Hoagland has been made master boiler maker of the Great Northern, at Judith Gap, Mont.

C. Dean has been made master boiler maker of the Wabash, at Fort Wayne, Ind., vice C. C. Zollinger, deceased.

Robert Ross has resigned his position as foreman boiler maker with the Central Vermont Railroad and has gone into the hotel business at Sidney, C. B.

A. R. Hodges, formerly foreman of the Inter-Oceanic Railway at Puebla, Mexico, has accepted the position of general foreman boiler maker for the Atchison, Topeka & Santa Fe Railway at Topeka, Kan., vice Gus Mehleison, who has been appointed general boiler inspector of the Eastern division of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan.

In our June issue, Mr. J. A. Shay was erroneously reported to have succeeded Mr. Henry F. Gilg as sales manager of the Carter Iron Company, Pittsburg, Pa. Mr. Shay has succeeded Mr. Gilg as sales manager of the Sligo Iron & Steel Company, Connellsville, Pa., and Mr. Gilg is now connected with the Carter Iron Company, of Pittsburg.

COMMUNICATIONS.

In Reply to a Reader's Query.

Editor The Boiler Maker:

In answer to "A Reader" whose questions appear in the June, 1910, issue of the paper, page 185, I offer the following:

1. The blow-pipe on a locomotive boiler is usually from 1½ to 2½ inches diameter.

2. The rule for figuring the horsepower of a locomotive boiler is this:

Thirty pounds water evaporated into dry steam from a feed-water temperature of 100 degrees F., and under a pressure of 70 pounds per square inch gage. The term "horsepower" is really not applicable to any boiler, as a boiler does not *work* in the sense that the word is used in mechanics. Sometimes boilers are given a horsepower rating according to the number of square feet of heating surface contained, or the number of feet of grate area.

3. If the telescope end of the pipe is too *high*, the greatest draft will be through the lower tubes, and the fire will burn best in the front end of the fire-box. If the telescope end of the pipe is too low, the greatest draft will be through the upper tubes, and the fire will burn best at the back end of the fire-box.

4. Yes, the diaphragm plate does control the burning of the fire. If the fire is burning too briskly at the front end the draft is too strong through the lower tubes, and the diaphragm plate is too low; therefore, it should be raised to remedy the trouble. If the fire at the back end of the grate does not burn briskly enough, the diaphragm should be raised so as to get a better blast through the top tubes, which will cause a better fire at the back end.

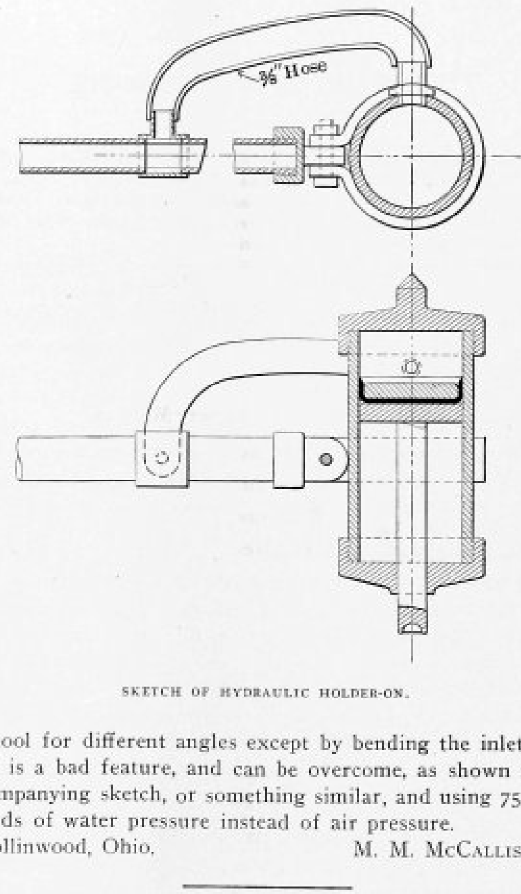
5. Generally speaking, a boiler should be tested hydrostatically to a pressure exceeding the safe working pressure by 50 percent. That is, for instance, if 100 pounds per square inch is to be the safe working pressure, the test pressure should be 150 pounds per square inch, or you can state it like this: The safe working pressure may be two-thirds of the hydrostatic test pressure. But different shops may have different methods and rules in relation to this matter; for example, in some places it is customary to test a boiler after repairs to 100 pounds per square inch more than the pressure of steam to be carried. Sometimes extra steam pressure may be applied as a test to the extent of 60 pounds per square inch above that to be carried when the boiler is in regular operation, but the 50 percent rule is a good one for the purpose. Chas. J. Mason.

Scranton, Pa.

Suggestion for a Holder-On.

Editor The Boiler Maker:

In regard to the holder-on described on page 149, May issue, the dimensions are satisfactory and also the general design of the tool, except there seems to be no means of adjustment of



SKETCH OF HYDRAULIC HOLDER-ON.

the tool for different angles except by bending the inlet pipe. This is a bad feature, and can be overcome, as shown in the accompanying sketch, or something similar, and using 75 or 80 pounds of water pressure instead of air pressure.

Collinwood, Ohio. M. M. McCallister.

Performance of the Wood Fire-Box.

Editor The Boiler Maker:

I note in the report of the annual convention of the International Boiler Makers' Association, in your June number, a statement by Mr. F. A. Linderman regarding the Wood fire-box, in which he says that the first one went into service a year ago last December, and they have had more trouble with these boilers with leaking stay-bolts than with any others. We can hardly believe that Mr. Linderman made this statement, and am of the opinion that there must have been some mistake in the stenographer's notes, for Mr. Linderman is well aware of the fact that the reverse is the case; in fact, it is a matter of record in the office of the general superintendent of motive power of the New York Central.

In a recent conversation with Mr. J. F. Deems, general superintendent of motive power, in regard to the Wood fire-box, he informed the writer that these fire-boxes had met his expectations, and that a comparison of the three Wood fire-boxes, which had been in service forty-four months, with three other fire-boxes which had been in service forty-five months, was very favorable to the Wood fire-box, especially so far as stay-bolts were concerned. The writer was given the exact figures on these matters under promise that they would not be published, but they can be obtained from either Mr. Deems or the writer by anyone who is sufficiently interested.

Washington, D. C. H. A. GILLIS.

[EDITOR'S NOTE:—Mr. Linderman's remarks regarding the Wood fire-box, to which our correspondent refers, were correctly reported in the June issue of THE BOILER MAKER, but as Mr. Linderman wished to be absolutely fair with the Wood Company, he subsequently requested that his remarks be left out of the official proceedings of the International Master Boiler Makers' Association.]

TECHNICAL PUBLICATIONS.

Jordan's Tabulated Weights of Iron and Steel. Sixth edition. By Charles H. Jordan, M. I. N. A. Size, 5 by 3⅛ inches. Pages, 640. Numerous illustrations. London, 1909: E. & F. N. Spon, Ltd., and New York, 1909: Spon & Chamberlain. Price, 7/6 net.

The new edition of this well-known work is necessitated in part by the alterations which have recently been made in the rules of *Lloyd's Register of Shipping* by the adoption of a decimal system in denoting the thicknesses of various sections of steel to be used in the building of vessels for classification in this society. This alteration has necessitated the production of a series of tables of weights and sectional areas in accordance therewith. These tables have, therefore, been added to the present edition, and they are based upon the British standard ship sections as drawn up by the Engineering Standards Committee and approved by Lloyds.

The volume includes tables of weights of iron and steel plating and sections of various standard gage thicknesses and diagrams and sectional areas of various iron and steel shapes; weights and sectional areas of steel in thicknesses of twentieths and fortieths of an inch; weights and sectional areas of steel in thicknesses of thirty-seconds of an inch; equipment weights for all classes of vessels; tables of decimal equivalents of the foregoing; tables of equivalent weights and measures in metric and British units, and finally the additional tables of weights and sectional areas of steel sections contained in Lloyd's Rules, based upon the British standard sections in thicknesses of fiftieths of an inch and also decimal equivalents, etc.

Weights of Steel Stacks per Lineal Foot. By G. A. Schust, M. E. Size, 4 by 6¾ inches. Pages, 8. Fort Wayne, Ind.: G. A. Schust. Price, 75 cents.

This pamphlet is one of a series of engineering leaflets published in convenient form to aid draftsmen, designers and layers out. The weights of steel stacks per lineal foot are given in tabular form for stacks ranging in diameter from 12 to 150 inches, constructed of material from 16 gage to 9/16 inch. The weight per foot includes laps and rivets and the usual percentage for overweight in rolling. Information is also given for the proper size rivet to use, the amount of lap to allow for different thickness of material, and the average pitch of rivets. This leaflet will be found very convenient and useful to anyone who has to design or lay out steel stacks.

Metal Spinning. By C. Tuells and William A. Painter. Size, 6 by 9 inches. Pages, 38. Illustrations, 45. New York, 1910: The Industrial Press. Price, 25 cents.

This pamphlet is one of a reference series got out by the publishers of *Machinery*. Each pamphlet is one unit in a complete library of machine design and shop practice revised and republished by the magazine. The contents of the pamphlet under review consist of a chapter on Principles of Metal Spinning by Mr. Tuells, and one on Tools and Methods Used in Metal Spinning by Mr. Painter, both articles being reprints from previous issues of *Machinery*. The articles are comprehensive, well illustrated and give the reader an excellent idea of the operation of spinning and the methods and tools used in spinning for rapid production.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—What is the rule for finding the required length of a rivet when the thickness of the metal between the rivet heads is given, assuming the rivet hole to be 1/16 inch greater diameter than the rivet before it is heated.

A.—Rules for the length of rivets such as you desire are unsatisfactory, and it has been found more useful to use a table such as is printed below, which is based on the best results obtained in practice. In the table the grip in inches means the thickness of metal between the rivet heads.

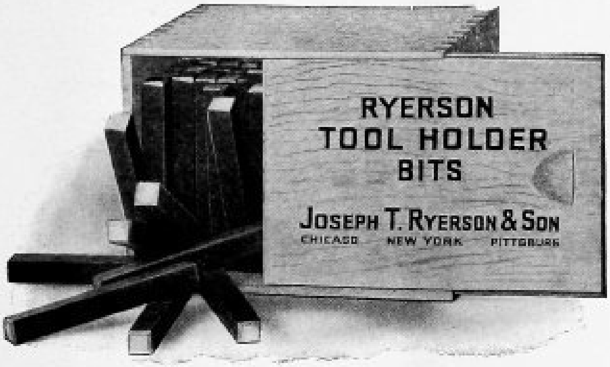
ROUND HEAD RIVETS.

Grip in Inches.	Diameter in Inches.				
	1/2	5/8	3/4	7/8	1
	Length in Inches.				
1/2	1 1/2	1 3/4	1 7/8	2	2 1/8
5/8	1 5/8	1 7/8	2	2 1/8	2 1/4
3/4	1 3/4	2	2 1/8	2 1/4	2 3/8
7/8	1 7/8	2 1/8	2 1/4	2 3/8	2 1/2
1	2	2 1/4	2 3/8	2 1/2	2 5/8
1 1/8	2 1/8	2 3/8	2 1/2	2 5/8	2 3/4
1 1/4	2 1/4	2 1/2	2 5/8	2 3/4	2 7/8
1 3/8	2 3/8	2 5/8	2 7/8	2 7/8	3
1 1/2	2 5/8	2 7/8	3	3 1/8	3 1/4
1 5/8	2 3/4	3	3 1/8	3 1/4	3 3/8
1 3/4	2 7/8	3 1/8	3 1/4	3 3/8	3 1/2
1 7/8	3	3 1/4	3 3/8	3 1/2	3 5/8
2	3 1/8	3 3/8	3 1/2	3 5/8	3 3/4
2 1/8	3 1/4	3 1/2	3 5/8	3 3/4	3 7/8
2 1/4	3 3/8	3 5/8	3 3/4	3 7/8	4
2 3/8	3 1/2	3 3/4	3 7/8	4	4 1/8
2 1/2	3 5/8	3 7/8	4	4 1/8	4 1/4
2 5/8	3 3/4	4	4 1/8	4 1/4	4 3/8
2 3/4	3 7/8	4 1/8	4 1/4	4 3/8	4 1/2
2 7/8	4	4 1/4	4 3/8	4 1/2	4 5/8
3	4 1/4	4 1/2	4 5/8	4 3/4	4 7/8
3 1/8	4 3/8	4 5/8	4 3/4	4 7/8	5
3 1/4	4 1/2	4 3/4	4 7/8	5	5 1/8
3 3/8	4 5/8	4 7/8	5	5 1/8	5 1/4
3 1/2	4 3/4	5	5 1/8	5 1/4	5 3/8
3 5/8	4 7/8	5 1/8	5 1/4	5 3/8	5 1/2
3 3/4	5	5 1/4	5 3/8	5 1/2	5 5/8
3 7/8	5 1/8	5 3/8	5 1/2	5 5/8	5 3/4
4	5 1/4	5 1/2	5 5/8	5 3/4	5 7/8
4 1/8	5 3/8	5 5/8	5 3/4	5 7/8	6
4 1/4	5 1/2	5 3/4	5 7/8	6	6 1/8
4 3/8	5 5/8	5 7/8	6	6 1/8	6 1/4
4 1/2	5 3/4	6	6 1/8	6 1/4	6 3/8
4 5/8	6	6 1/8	6 1/4	6 3/8	6 1/2
4 3/4	6 1/8	6 1/4	6 3/8	6 1/2	6 5/8
4 7/8	6 1/4	6 3/8	6 1/2	6 5/8	6 7/8
5	6 3/8	6 1/2	6 5/8	6 3/4	7

ENGINEERING SPECIALTIES.

Ryerson Tool Holder Bits.

Joseph T. Ryerson & Son, Chicago, Ill., are now putting on the market Ryerson tool holder bits, which are the new high-speed steel already hardened in tool holder sizes, cut in 3-inch lengths and packed in small boxes. The only work necessary

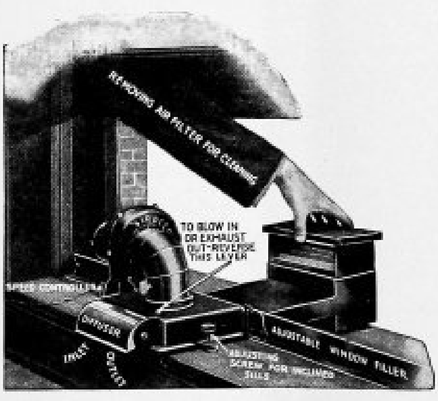


is to grind to shape. This will meet with great favor among small shops, as it means considerable saving in material, time and, owing to the excellent facilities which the manufacturers have for hardening, best results are obtained from the high-speed tool steel.

The Sirocco Electric Fan and Air Purifer.

The "Sirocco" electric fan and air purifier is a device developed by the American Blower Company, Detroit, Mich., and Troy, N. Y., using a "Sirocco" (trade mark) standard turbine type impeller wheel but 3 inches in diameter as the basis for bringing the fan system of ventilation within the reach of everyone using electric current. The small space occupied and the light weight combine to make the "Sirocco" device portable and attractive.

On account of the high efficiency of the "Sirocco" fan the electric motor is small (one-seventieth of a horsepower), and the electric current requirement almost insignificant. The

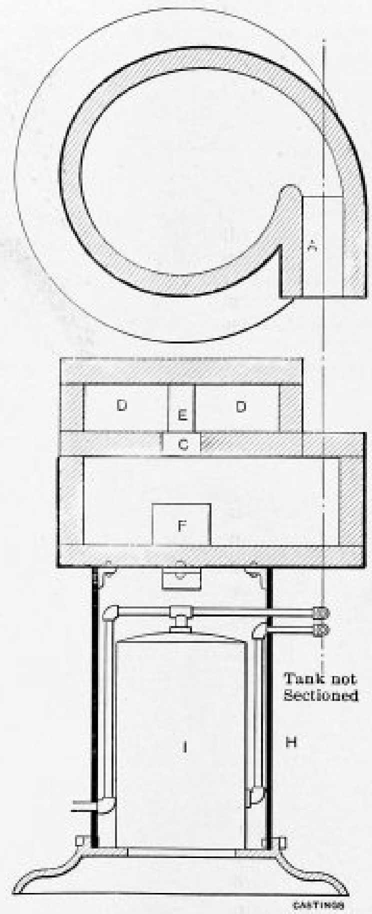


complete outfit can be installed upon the windowsill by the office boy or stenographer without tools.

"Sirocco" will supply 5,000 cubic feet of fresh, filtered air every hour, diffusing same throughout the room or in any direction at will, or deflecting through radiator for winter ventilation. By the simple reversal of a small lever, without changing the position of the outfit or stopping same, "Sirocco" will exhaust from the room the dead "used-up" air in the same large volume. It is not a mere agitator of the air in an apartment, and it goes beyond any other ventilating device yet made. The design has been perfected and patents applied for, and manufacturing facilities are being hurried into shape for the production of these remarkable units by the thousands. The complete outfit consists in addition to the "Sirocco" fan-motor and reversing mechanism, of an adjustable outlet nozzle for summer use, speed controller, a dozen filter cloths and window sash lock which prevents the window being raised from the exterior after the outfit is in place, and a rustless steel window filler adjustable to standard width sashes.

Monarch Rivet-Heating Furnace.

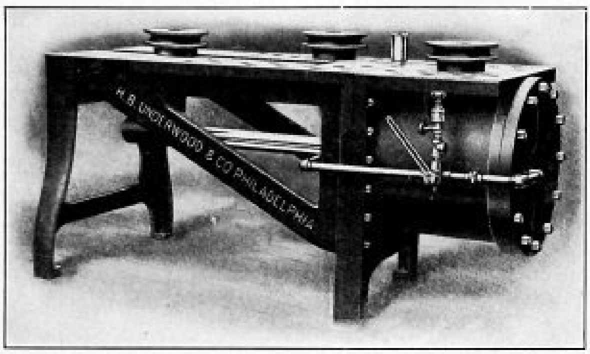
The Monarch Engineering & Manufacturing Company, Baltimore, Md., have on the market a portable rivet-heating furnace which is especially recommended for ship, bridge, boiler and general construction work. Oil or gas is used as the fuel, and, referring to the illustration, the flame is directed into combustion chamber *A*, where the oil is thoroughly ignited. It then passes into the heating chamber *B*, the construction of which gives the flame its rotary motion, dis-



tributing the heat uniformly throughout the whole interior. The waste heat escapes through the opening *C*, and distributes itself into the open chamber *D*, where the rivets may be placed prior to their being put into the heating chamber *B*. The furnace is supported on a steel cylindrical sheet, which contains the fuel oil tank *I*, and the whole is mounted on a cast iron base. The furnace top is made of steel, securely welded together, with angles riveted to the bottom, so that the furnace top may be set on to the sheet without being permanently attached to it. It is claimed that the furnace carries a high, soft, uniform heat, and is always under control of the operator, the rivets always being in plain sight and readily reached. The capacity of the furnace is claimed to be 3,000 ¾-inch rivets per day, and from 1½ to 2 gallons of oil are consumed per hour, according to the quantity of rivets heated.

New Underwood Pipe-Bending Machine.

The pipe bender which is shown in the accompanying illustration has been placed on the market by H. B. Underwood & Company, 1025 Hamilton street, Philadelphia, Pa., and besides being efficient for the bending of pipes may also be employed as a bulldozer and power bender. The length of stroke is 15 inches, and the control very flexible. The rectangular work table is of ample dimensions, and numerous holes are provided for conveniently locating dies and pins. No obstruction that will interfere with the work in any way is presented by the top of the table, as it is perfectly flat. The large number of dies which are ordinarily required for bending a great variety of pieces is avoided, as simply changing the position of the resistance studs permits varying the shapes at will. The ram, located beneath the table, slides in a strongly constructed guide, and is provided with a stud projecting above the table on which a roll of suitable size may be placed. Steam or compressed air may be used to operate the machine, and for the former a



metallic packing is used on the piston rod and for the latter a leather packing. The use of compressed air has many advantages over the use of steam, and the maker recommends it as a motive power when available. The diameter of the cylinder is 20 inches, and the supply of working fluid admitted to the piston is the only limit placed on the power of the machine.

A special feature that is very advantageous and worthy of particular attention is that the piston has air on both sides of it at all times. Because of a special construction of the operating valve only the amount of working fluid required for actual bending is wasted, as it is transferred from one side of the piston to the other, and the piston is forced forward because that side offers a larger area than the other, which is smaller because of the space occupied by the piston rod. Thus the piston can be moved only a fraction of an inch when necessary, or it may be held perfectly stationary for measuring the work. Such a precise control is desirable in all sorts of bending work and is particularly useful in straightening bent pieces.

Vanadium Tool Steel Rivet Dies.

The breaking of rivet dies constitutes an endless expense and often causes annoying and costly delays, and it is therefore a very important matter to secure a steel that will stand up well under this service. Joseph T. Ryerson & Son, Chicago, Ill., have on the market a special vanadium steel which, it is claimed, is especially adapted for this class of work. This steel has been brought out as the result of years of investigation and study, and it is claimed that it will not upset, but that it is hard, tough and offers the ultimate resistance to crystalization attainable in a steel used for this purpose.

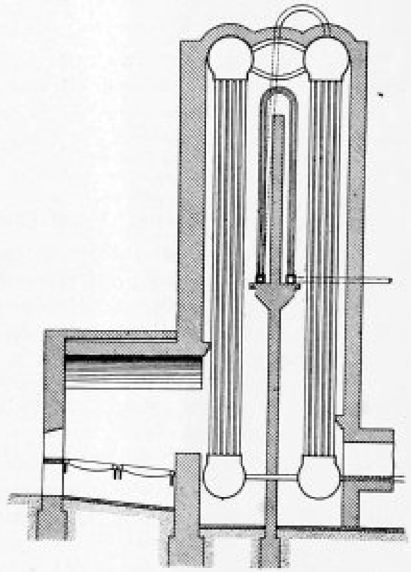
Previous to the adoption of this steel for this purpose the concern for which this die was made had continuous trouble owing to the fact that the constant vibration crystalized the shank, and the dies broke off at the shoulder. After the vanadium steel die was adopted it was found that this die could be kept in continuous service for fourteen months, during which time it was used on work in which a great many 7/8-inch rivets were redriven cold, and it is stated that no trouble was experienced with the dies.

SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

954,914. SUPERHEATER-BOILER. JOHN E. BELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A superheater boiler having two or more transverse steam and water drums connected by banks of tubes to a mud drum or drums, a baffle or partition between the banks of tubes and a super-



heater having tubes extending on both sides of the partition between it and the water tubes, said superheater being independent of the boiler drums. Seven claims.

956,986. BOILER-TUBE SPREADER. JOHN J. MAHER, OF PHILADELPHIA, PA., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

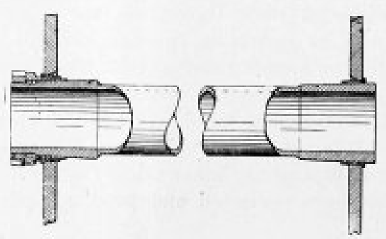
Claim 3.—A boiler-tube spreader comprising a bar and a spreader member formed of oppositely-extending arms, said arms being rigidly secured to said bar and projecting laterally therefrom on the same side of the bar. Four claims.

957,856. REMOVABLE WATER-HOLDING ARCH PLATE. CHARLES H. FELDMANN, OF PORTLAND, ORE.

Claim 1.—The combination with a rear flue sheet, of a tubular boiler and a three-sided closure therefor constituting a return-flue chamber, of an arch plate constituting a top closure for such return-flue chamber, said arch plate being of pan-like shape and open at the top, a water inlet pipe arranged to discharge into the pan, and said arch plate being adapted to discharge the water therein above a predetermined level. Four claims.

958,910. DETACHABLE BOILER FLUE. JULIAN F. DRAKE, OF TRACY, MINN., ASSIGNOR OF ONE-HALF TO JOSEPH KEMNA, OF MINNEAPOLIS, MINN.

Claim 1.—In a boiler, the combination, with the flue sheets having flue seats extending therethrough from one side to the other, said seats being tapered from the outer toward the inner surfaces of said sheets, of



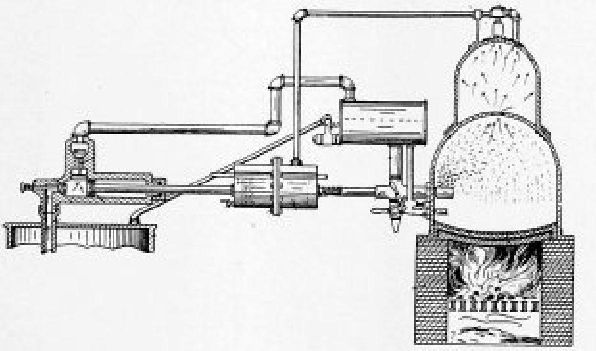
a flue having tapered ends, the taper at the fire box end of said flue being toward the middle of the flue and the taper of the opposite end of the flue being toward its outer end, whereby a tool may be applied to drive the flue through the flue sheets into the fire-box, packing rings interposed between the ends of the flue and the seats thereof, a tapered sleeve fitting between the flue and its packing ring at the end thereof opposite from the fire-box, and means for locking said sleeve against premature outward movement, said means including a groove having a diagonally arranged cam edge and a pin co-operating with said groove. Three claims.

958,202. BOILER-TUBE CLEANER. HENRY F. WEINLAND, OF SPRINGFIELD, OHIO, ASSIGNOR TO THE LAGONDA MANUFACTURING COMPANY, OF SPRINGFIELD, OHIO, A CORPORATION OF OHIO.

Claim 1.—The combination with a body having spindles with arms pivoted thereon to swing in planes transverse to the axis of the body, bolts with cutters thereon mounted in said arms and means adapted to swing on said spindles to secure said bolts in place. Six claims.

957,155. STEAM BOILER. WILLIAM M. GENTLE, OF SOUTHPORT, IND.

Claim 2.—A steam boiler, a water tank, a tube extending into the boiler, the portion thereof within the boiler being perforated to form a spraying nozzle, a conduit from the water tank to said tube, a pair of pistons and piston rods operable in said tube, a yielding connection



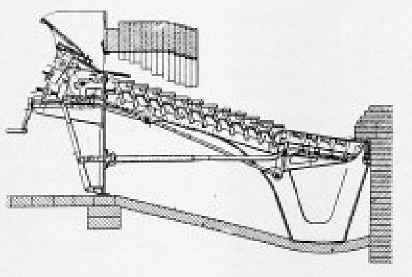
between the piston rods of the two pistons that holds one piston normally a certain distance in advance of the other, and a stop to limit the forward movement of the advancing piston, whereby the chamber between the two pistons receives a certain volume of water, and it is conveyed by said pistons to the nozzle and discharges after the movement of the advancing piston is stopped. Ten claims.

961,528. FURNACE-GRATE. HERMAN A. POPPENHUSEN, OF EVANSTON, ILL.

Claim 1.—The combination with a furnace, of a grate comprising a plurality of grate-bars extending from front to rear of the furnace, each of said grate-bars embracing two longitudinally arranged members pivotally connected with each other at the forward end of the bar, means acting severally on the forward ends of the bars, acting to give endwise reciprocatory and rising and falling motion to the forward ends of both members of each bar, supporting means for the rear ends of the bars affording a supporting surface for each member of each bar, and means operated by the endwise movement of each bar, acting in connection with the supporting surface to give rising and falling vibratory motion to the rear end of one of said members relatively to the rear end of the other member of the bar. Five claims.

957,296. MECHANICAL STOKER FOR FURNACES. FRANK C. ARMSTEAD, OF PITTSBURG, PA., ASSIGNOR TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 3.—In a self-feeding furnace, the combination with a feeding grate, a main shaft, an intermediate mechanism for effecting the operation of the grate, of a hinge-supported dumping grate, a drum on the



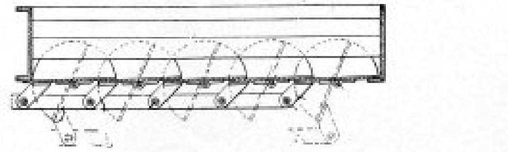
main shaft, a chain and a rod connecting said drum with the free end of said dumping grate, a worm gear for rotating said drum and a locking device to relieve the drum and worm wheel of strains when the dumping grate is in the normal position. Thirteen claims.

962,734. CHAIN-GRATE FURNACE. ALFRED W. BENNIS, OF LITTLE HULTON, ENGLAND.

Claim 1.—In a furnace, a revolving chain grate; a hinged imperforate ash-chamber floor with its outer end extending under the lower straight run of the grate; and means for positively holding one edge of said floor up against the under side of said chain grate; thereby forming an ash-seal between the floor and the under side of said chain grate. Eight claims.

959,106. ASH PAN FOR LOCOMOTIVES. LEANDER R. BATTLE, OF LAKELAND, FLA.

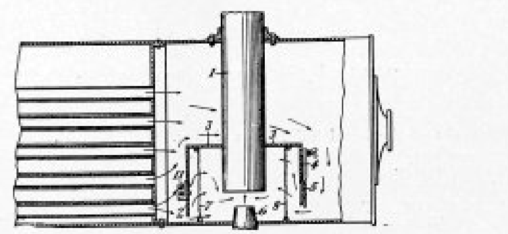
Claim.—A device comprising an ash pan having a bottom composed of a series of overlapping slats, said slats being pivotally mounted within the frame of said pan, shield portions integral with said slats and extending upwardly and outwardly therefrom and contacting with the sides of said pan, said shield portions being substantially semi-circular in outline and overlapping one another when in a closed position, brackets approximately T-shaped secured at their heads to the under sides of said slats, the tongues of said brackets extending at angles of 45 degrees to the plane of said slats, an actuating lever comprising two parallel



bars spaced apart, said bracket tongues being inserted there between and secured thereto, whereby when said lever is moved back and forth said slats are opened and closed. One claim.

959,333. DRAFT EQUALIZER FOR LOCOMOTIVE FRONT ENDS. JOHN FOURNIA, OF ALBANY, N. Y., ASSIGNOR OF ONE-HALF TO FREDERICK RANDALL GREENE, OF ALBANY, N. Y.

Claim 3.—In a locomotive front end, in combination with the draft pipe extending below the center of the smoke-box, a draft-equalizing



device embracing the lower end of the draft pipe and arranged to deflect the draft over said device and thence down over the bottom of the smoke-box. Eleven claims.

956,589. SPARK-ARRESTER AND SMOKE-CONSUMER. WILLIAM TAYLOR LUPTON AND JAMES McSHERRY LUPTON, OF BERKELEY COUNTY, W. VA.

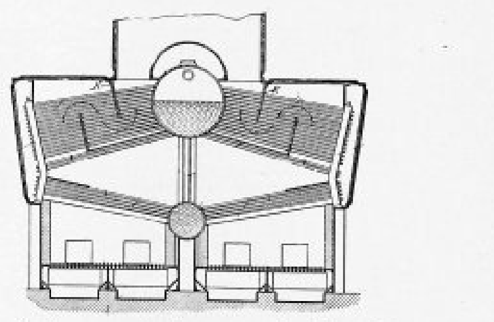
Claim 1.—In apparatus for eliminating sparks and smoke, the combination with a furnace and a smokestack, of a return pipe from said stack to said furnace provided with a lateral discharge vent opening to permit escape of a portion of products of combustion, a deflector adjacent said opening extending in the general direction of movement of the products of combustion impinging thereagainst for guiding the heavier particles away from said opening, and means for causing a forced circulation through said return pipe. Seventeen claims.

956,517. FURNACE GRATE. THOMAS DAWSON, OF LIVINGSTON MANOR, N. Y.

Claim 1.—A hollow slotted grate bar for furnaces formed convex on its upper side and provided with a concave chamber beneath, said grate bar having heads closing said concave chamber at its ends, said end heads being provided with pivots, so that said bar may rock in a fulcrum which is within the horizontal plane of said heads, and said grate-bar having an intermediate transverse strengthening web filling said concave chamber crosswise and being provided with a downwardly extending operating arm. Five claims.

959,612. WATER-TUBE STEAM GENERATOR. JAMES H. ROSENTHAL AND ARTHUR SPYER, OF LONDON, ENGLAND, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A water-tube boiler comprising a water drum and a steam and water drum, headers, a bank of tubes extending from opposite sides of the water drum to the lower part of the headers and inclined up-



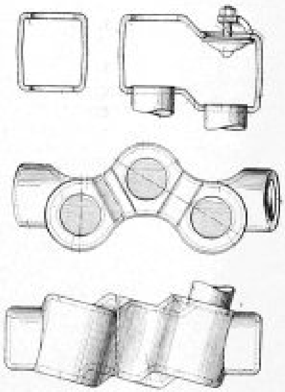
wardly, a bank of tubes extending from opposite sides of the steam and water drum to the headers and inclined downwardly, and baffles in the uper banks of tubes forming passes for the products of combustion, the first pass being at the lower ends of the tubes, and down-comer tubes connecting the said drums. Five claims.

958,433. OIL-BURNING FURNACE. CLAYTON C. PHIPPS, OF SAN DIEGO, CAL.

Claim 2.—In an oil-burning furnace, in combination with the front, rear and bottom walls thereof, a bridge wall located to the rear of the front wall, a series of air pipes on the bottom wall, which air pipes extend through the rear wall and through the bridge wall, a hood on the rear wall overlying the rear ends of the pipes, a damper connected to the hood to regulate the ingress of air into the pipes, a shelf-like member carried by the rear wall to co-operate with said damper, the front ends of the air pipes extending through the bridge wall at the base thereof, and a burner located in front of the bridge wall adjacent the top thereof. Two claims.

960,044. BOILER-HEADER. WILLIAM F. SELLERS, OF WILMINGTON, DEL.

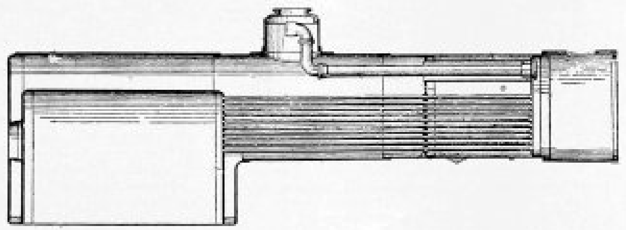
Claim 1.—A vertical sinuous header for a sectional boiler with inclined water tubes, in the form of a one-piece shell comprising a vertical series of cylindrical portions having their axes parallel to the water



tubes, and arranged with alternate portions laterally displaced with respect to the intermediate portions, each cylindrical portion having ends perpendicular to the axis of the portion, with a tube opening in one end and a hand hole in the other end with an internal cover seat at the margin of the hand hole. Six claims.

960,364. FEED-WATER HEATING APPLIANCE. CARL J. MELLIN, OF SCHENECTADY, N. Y., ASSIGNOR TO AMERICAN LOCOMOTIVE COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

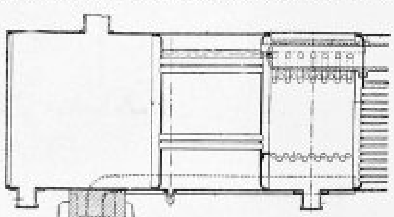
Claim 2.—The combination, with a tubular steam boiler, of a transverse water-retarding partition or diaphragm secured to the inside of the boiler shell and interposed between a feed-water heating space adjoining the discharge ends of the tubes and a steam generating space in rear



thereof, a plurality of fire tubes passing through perforations of slightly larger diameter in the partition, the spaces intervening between the tubes and said perforations being restricted so as to permit only a retarded traverse of water in thin films, heated water supply perforations formed in the partition above the top row of fire tubes, and a feed-water supply connection opening into the feed-water heating space. Four claims.

960,704. FEED HEATING AND SUPERHEATING BOILER. SIDNEY A. REEVE, OF WORCESTER, MASS., ASSIGNOR TO CHARLES F. BROWN, TRUSTEE, OF READING, MASS.

Claim.—A locomotive-type superheating boiler comprising a vaporizing chamber traversed by the furnace gases and having a steam outlet, a gas chamber forward of the vaporizing chamber having side openings in its opposite walls provided with removable covers, an upper manifold



structure connected with the steam outlet of said vaporizing chamber, two eduction manifolds, two sets of superheating coils occupying said gas chamber and removable respectively through the opposite side openings of the chamber, and removable fastenings connecting the ends of said coils with the upper and lower manifolds. One claim.

960,711. FIRE-BOX DOOR WITH DRAFT DEVICE. JAMES A. SANDY, OF MINNEAPOLIS, MINN.

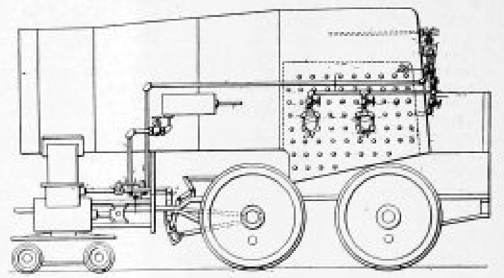
Claim 3.—The combination with a fire box, of a door therefor made up of two hinged sections, the upper door section having an intermediately projecting deflecting hood extending downward to the plane of the lower edge thereof and an air passage which feeds air beneath said hood, and the lower door section having a vertically adjustable choke plate extending above the lower portion of said hood and normally closing more or less of the air passage beneath said hood. Five claims.

960,806. LOCOMOTIVE ASH-PAN DUMPING DEVICE. WILLIAM J. BROWN, OF CHICAGO, ILL.

Claim 1.—In a locomotive ash pan, a drop bottom comprising two leaves hinged at the lower side of the pan and adapted to swing upwardly for closing the same; two pistons and chambers in which they respectively reciprocate; operating connections from the pistons to the leaves respectively for opening and closing them, one of said leaves having an extension which laps under the other leaf at their proximate edges for upholding said other leaf, and a catch for securing the leaf having such extension. Eight claims.

961,072. SMOKE CONSUMER. CHARLES F. HARRIS, OF ALTOONA, PA.

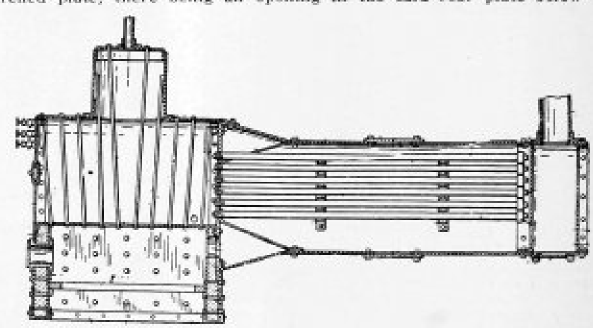
Claim 1.—The combination of a boiler, a furnace for heating the same, an engine including a valve mechanism for admitting and exhaust-



ing the steam to and from the engine, and means connected with the valve mechanism and positively actuated thereby for admitting fluid to the furnace. Eighteen claims.

961,082. STEAM BOILER. JAMES BUYHERS, OF CASEY, ILL.

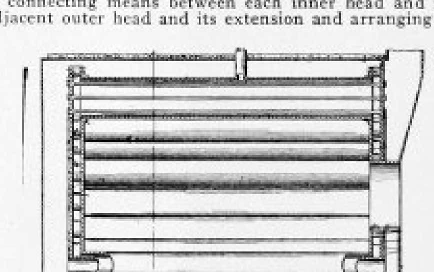
Claim 1.—In a steam boiler of the kind described, the combination of an arched plate having its sides disposed downwardly and substantially parallel to each other, a frontal plate and a rear plate, a crown sheet riveted to the frontal plate and the rear plate and to the sides of the arched plate, there being an opening in the said rear plate below the



crown sheet, refractory material to form an interior lining for that portion of the sides and the frontal and rear plates below the crown sheet, tubes having their open ends secured to the rear plate and having their rear ends closed, a shell to form a combustion chamber about the said tubes and being riveted to the rear plate, there being an opening in the shell at its rear end for a smokestack. Two claims.

961,490. STEAM-GENERATOR. ROBERT J. GALBRAITH, OF ALBANY, OREGON.

Claim.—A steam generator comprising inner heads spaced apart and each provided with an upwardly directed extension, outer heads spaced from said inner heads and each provided with an upwardly directed extension, connecting means between each inner head and its extension and the adjacent outer head and its extension and arranging the heads in



pairs at each end of the generator, one of said spaced pairs having a fuel opening therethrough, a plurality of relatively small tubes connecting the inner heads near their peripheries and spaced slightly apart with the tubes nearest the extensions spaced a greater distance apart, a plurality of flues connecting the outer heads and extending through the tubes which connect the inner heads, and a relatively large tube connecting the extension of the inner heads and above the large space between the upper tubes. One claim.

961,008. STEAM-BOILER GAGE. WILLIAM T. PIPER, OF NORTH ANDOVER, MASS.

Claim 1.—In a water gage for steam boilers comprising a sight tube, and steam and water valves, means co-operating with each of said valves normally tending to effect a closing thereof, restraining means for preventing operation of the valve closing means and holding said valves open, and means utilizing the steam at boiler pressure to hold the said restraining means in operative position under normal conditions and to release said valve closing means when the steam pressure is reduced under abnormal conditions to admit of the automatic closing of the said valves. Twelve claims.

THE BOILER MAKER

SEPTEMBER, 1910

THE APPLICATION OF GRAPHICAL CHARTS TO THE SOLUTION OF BOILER PROBLEMS.

BY F. A. GARRETT.

It is a well-known fact that where a considerable number of like problems, but with varying factors, have to be solved, no matter of what description they be, both time, labor and mistakes may be saved by suitably applying graphical methods to their solution. Although the mathematics of the boiler maker are far from being difficult, yet the use of charts will be found of advantage for both theoretical and practical problems, and it is hoped that the following few notes may be of interest to a large number of readers.

I have not seen any reference to this particular subject in any of my back numbers of THE BOILER MAKER, and I feel sure that the following will be regarded with much interest, and I hope also critically by a good number of practical men, as I believe that were the facilities which charts offer for the solution of practical problems more widely known, we should see a good many shop operations done more quickly than they are at the present time, especially on laying out jobs.

During my career in a particular boiler shop, I have taken much interest in chart work with reference to the laying out of plates, etc., and the number of cases where a simple chart would enable the job to be done in a fraction of the time that it takes by other methods seems to be without end. But, of course, if only a few problems have to be solved, "graphs" will be found to offer little advantage, and in many cases other methods are then more useful.

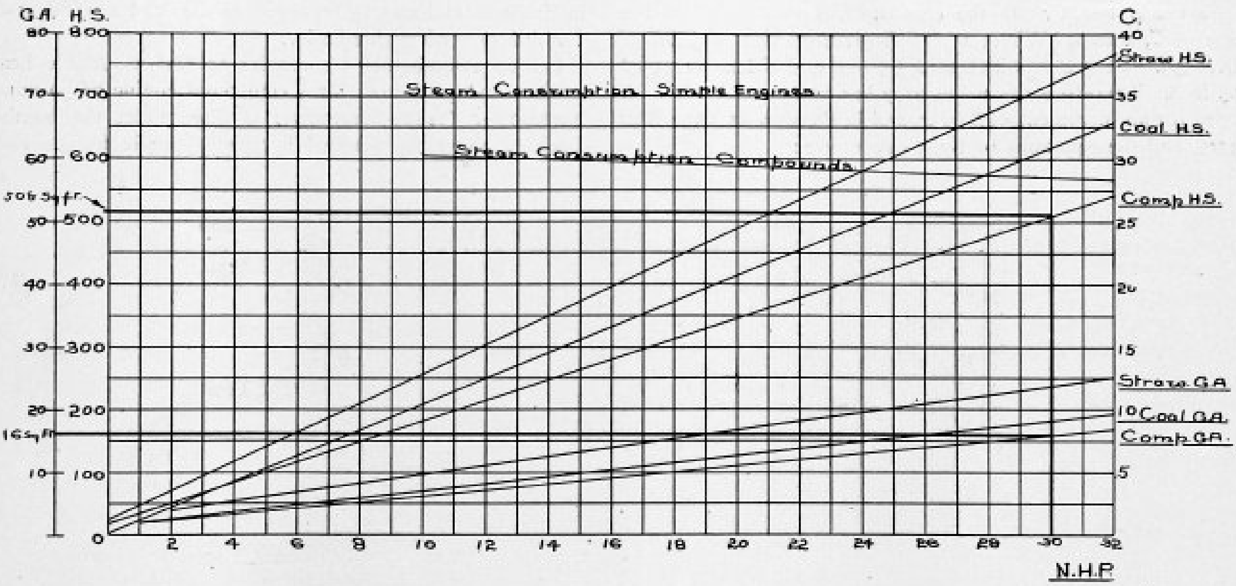


FIG. 1.—CURVES OF HEATING SURFACE, GRATE AREA AND STEAM CONSUMPTION OF PORTABLE LOCOMOTIVE TYPE BOILERS.

PRINCIPLES OF GRAPHICAL CHARTS.

For the benefit of readers who do not understand the fundamental principles of "plotting," it will be as well to state them briefly here. For the purpose of making a chart we require what is known as squared paper, which consists of paper ruled with vertical and horizontal lines, forming squares of ½ inch, 1 inch, 1 millimeter, etc., these being in turn divided up in ten or twelve equal parts. Such paper can also be obtained in any special ruling desired. Referring to Fig. 2, the horizontal axis is called the x axis, or axis of abscissæ, and the vertical the y axis, or axis of ordinates.

The simplest form of curve that we get is represented by the equation:

$$y = a + bx \quad (1)$$

$$\text{or } y = a - bx \quad (2).$$

These are commonly written:

$$y = a \pm bx \quad (3),$$

and it is known as a straight line law, because, when plotted on squared paper it gives a straight line, although in speaking of it we refer to it as a "curve." The value of a depends upon the point where the curve cuts the y axis, or ordinate, as seen in Fig. 2. The value of b depends upon the slope of the curve, and whether the sign is plus (+) or minus (—) depends upon whether the curve slopes up or down from the y axis, being + for curves B and C and — for curve A. For an example, let us find equations that will represent these curves in Fig. 2.

Curve A: The value of a is 4.5, as read off on the $o\ y$ axis when x equals zero, and when x is 8 (by running up that ordinate and across to the $o\ y$ scale) we read off 1.5. Now the original value 4.5 has become 1.5 while x has increased 8.

Therefore y has decreased $4.5 - 1.5 = 3$, while x has increased to 8, which gives us a decrement of $3/8 = .375$ for each value of x. Then this curve has the law $4.5 - .375\,x = y$.

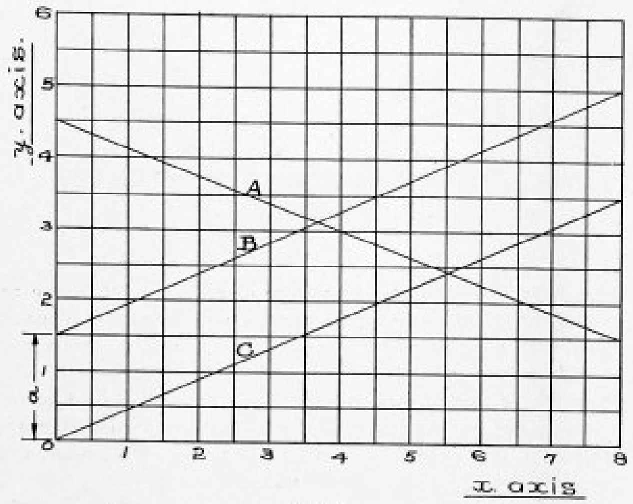


FIG. 2.

Curves B and C: In the case of B, $a = 1.5$, and in the case of C, $a = o$. Where $x = 8$ B gives a value of 5 and C gives 3.5. Then B has increased 3.5 in 8 and C has increased 3.5 in 8. Therefore the value of y has increased 3.5 in both cases for an increment of 8 of x, and in these cases $3.5 \div 8 = .4375$, and the equations of these curves are:

A set of curves which I have taken from practice is seen in Fig. 1, which represents the extent of heating surface and grate area for portable engine boilers of the locomotive type, as manufactured by the pioneer firm of this class of engine

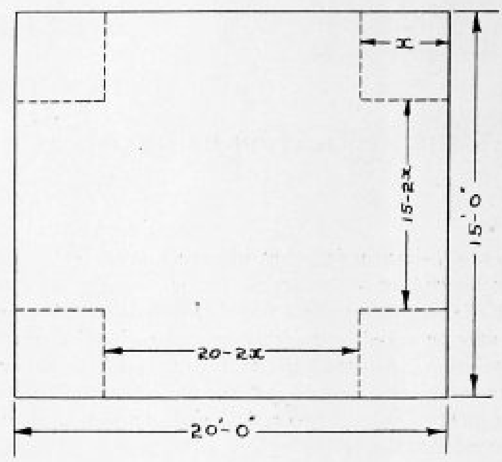


FIG. 3.

in England, and may be regarded as standard English practice for this type of engine boiler.

Let us assume that we require to find a suitable heating surface and grate area for a compound engine of 30 nominal horsepower (brake-horsepower is three times the nominal). Looking along the nominal horsepower scale for 30, run up

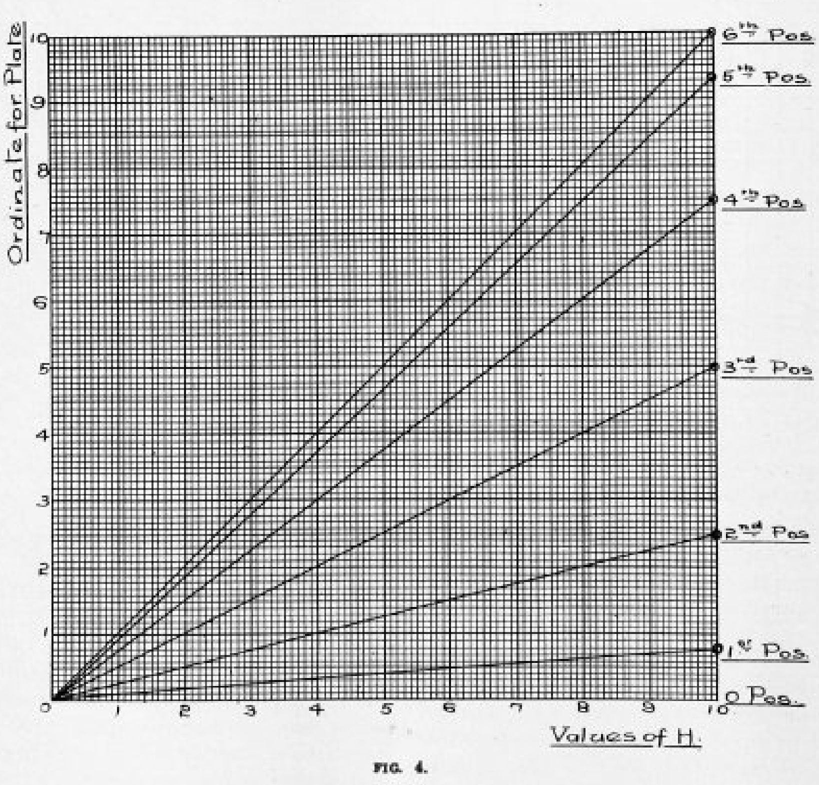


FIG. 4.

(A) $4.5 - .375\ x = y$.
(B) $1.5 + .4375\ x = y$.
(C) $0 + .4375\ x = y$.

It is easy to see that the value of y divided by the value of x gives us b.

this ordinate until we strike the curve marked "Comp. *G. A.*," and then across to the o y scale marked "*G. A.*" we read off 16 square feet. Now, going back to the 30 ordinate, we run up it till we come to the curve marked "Comp. *H. S.*," and then across to the o y scale marked *H. S.*, reading off 508.0 square feet. Therefore, a boiler with a heating surface of 508.0 square feet and a grate area of 16 square feet will be suitable proportions for a boiler to supply an engine of this particular type and horsepower.

I have also plotted the steam consumption of the engines as allowed in the design, which has a constant value of 35 pounds per brake-horsepower for simple engines and a decreasing quantity for the compounds as they get larger. This is due to better economy, etc., in compound engines of the higher powers.

The equations for these curves are as follows:

Coal-burning boilers, 100 pounds working pressure: *H. S.* = 3 + 6.84 brake-horsepower and *G. A.* = 1.5 + .1852 brake-horsepower.

Straw-burning boilers, 100 pounds working pressure: *H. S.* = 20 + 7.84 brake-horsepower and *G. A.* = 2.4 + .24 brake-horsepower.

Coal-burning boilers, 150 pounds working pressure: *H. S.* = 18 + 5.45 brake-horsepower and *G. A.* = 1.5 + .16 brake-horsepower.

The equations for steam consumption curves are:

Coal-burning and straw-burning simple engines: $C = 35$ brake-horsepower.

Coal-burning compound engines: $C = 30.94 - .2865$ brake-horsepower.

When using the chart for the steam consumption curves we use the scale marked *C:* the steam consumption per brake-horsepower hour scale.

A very interesting example of the use of squared paper will now be illustrated. A piece of sheet metal (Fig. 3) 20 feet by 15 feet is to be made into a tank by cutting out four equal square pieces from the corners and welding up. What must be the side x of the four corner squares to make a tank of the greatest holding capacity?

Let x equal the side of one of the corner squares. The depth of the tank will evidently be x. Its breadth will be $15 - 2x$, and its length $20 - 2x$. Then the volume $y = x(20 - 2x)(15 - 2x) = x(300 - 70x + 4x^2) = 300x - 70x^2 + 4x^3$.

Working a few examples with various substituted values of x and tabulating:

x	2.7	2.8	2.9	3.0
y	378.432	379.208	378.856	378.

It will be noticed that the numbers of y increase up to a certain point and then gradually decrease. By plotting these values of x and y on paper we find that y is a maximum when x has a value of 2.8 feet, which equals the side x of the corner squares and also the depth of the tank for a maximum holding capacity.

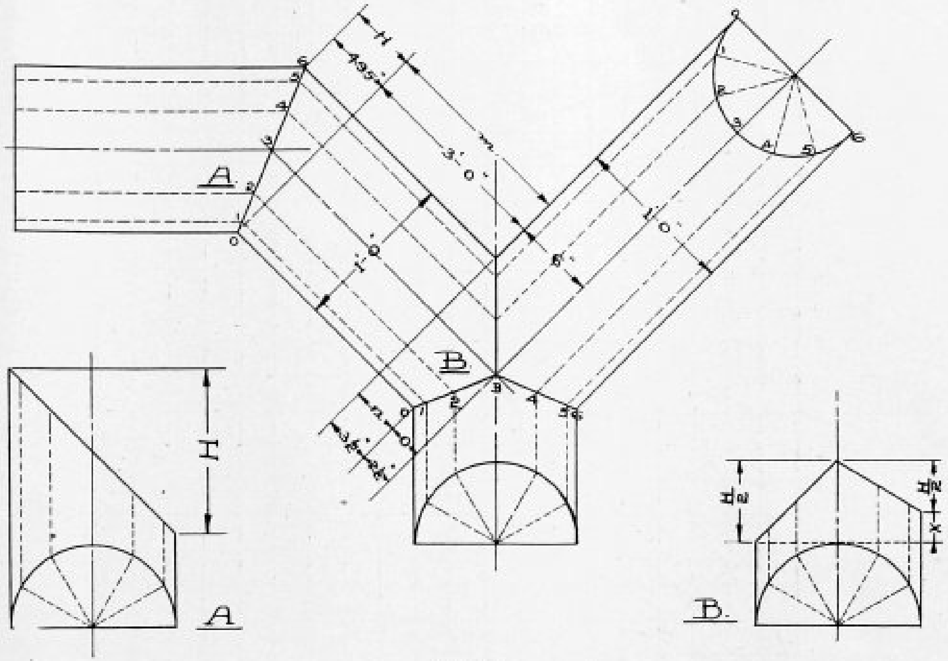


FIG. 5.

Probably the two following graphical charts will appeal to readers of this paper more strongly than any other part. During the past four months I have noted with interest the contributions to THE BOILER MAKER of articles on the development of sheets, more especially those of a cylinder cut at an angle and conical developments, and I have also noted the remarks on the method of triangulation with its slight inaccuracy, yet after all this discussion no *simple* and accurate method has been given as a substitute. Let us see if "graphs" will help us over the difficulty.

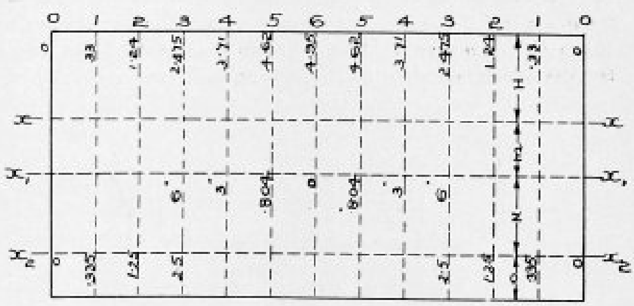


FIG. 6.

DEVELOPMENT OF CYLINDRICAL PIPE SHEETS CUT AT AN ANGLE.

For the purpose of laying out the development of this work I have constructed the chart shown in Fig. 4, by the aid of which the work can be laid out in a fraction of the time that it takes by any other method.

Upon a little thought or experiment it will be found that whatever the diameter of the pipes may be that have to be developed, the "projection" points for the "mitre" line will remain in the same position on each particular ordinate, so long as the total plate length is divided up into the same number of equal parts for every case; that is, whether the pipe is 2 inches or 2 feet in diameter. If we divide the circumference up into, say, twelve parts for each development, the

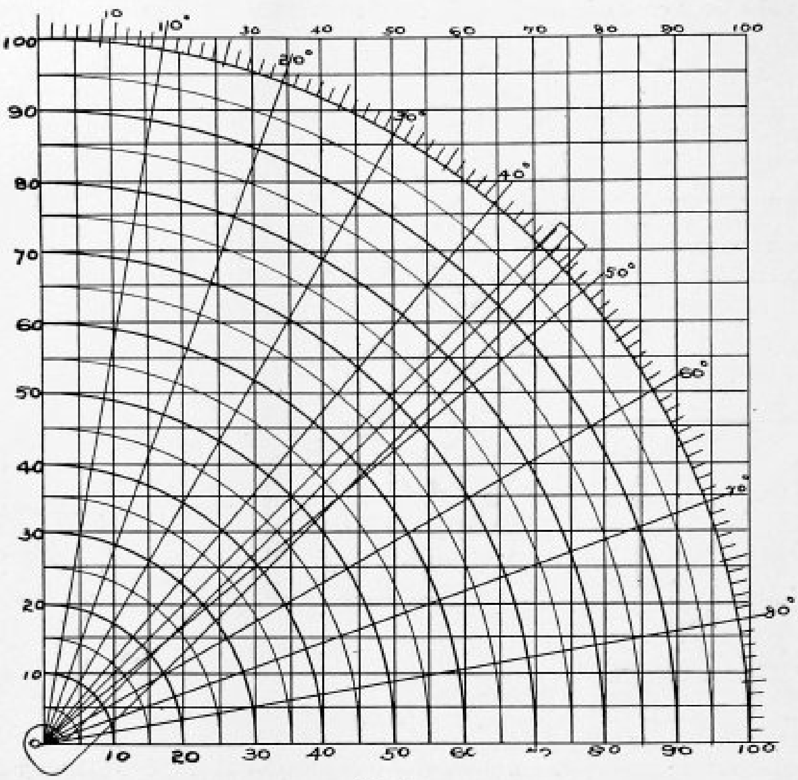


FIG. 7.

"projection" for the ordinates will remain the same height *if the value of H (Fig. 5A) is the same in each case.* We need not, therefore, trouble ourselves about the diameter of the pipes as far as the projection points are concerned.

For the sake of an example I have taken the case of a Y-pipe connection, similar to the one in THE BOILER MAKER of April, 1910, and propose to develop these plates with the aid of the chart shown in Fig. 4, where the values of H are plotted along the $o\ x$ axis, and the corresponding values for our projection points on the $o\ y$ axis. I have assumed the total plate length for the development to be divided up into twelve equal parts for every layout.

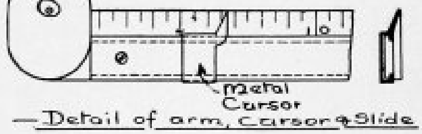


FIG. 8.

The chart from which the illustration is taken was one-fifth the size of the original, which, by the way is centimeter paper divided up into tenths, and the scale is 5 centimeters to 1 inch or foot. It will be found possible to read off five figures after a little practice. To enable readers to construct their own chart the following instructions are appended: Procure some squared paper ruled in 1/10th centimeter, the over-all size of sheet about 52 by 52 centimeters.

The equations for each "curve" are:

First position	$= .067\ H$	Fourth position	$= .75\ H$
Second "	$= .25\ H$	Fifth "	$= .933\ H$
Third "	$= .5\ H$	Sixth "	$= 1.0\ H$

Assume .10 is the value of H, and multiply by each of the coefficients, which will give us our points on the $H = 10$ ordinate:

First position	= .67	Fourth position	= 7.5
Second "	= 2.5	Fifth "	= 9.33
Third "	= 5.0	Sixth "	= 10.00

Having marked these points on the chart, all that remains to be done is to join up each point to the origin o by straight lines. In Fig. 5 I have put on dimensions in a manner that will facilitate the layout.

PIPE B, FIG. 5.

The total length of plate for this is $1 \times 3.1416 \times 12 = 37.699$ inches plus lap. Marking off the total length on the plate, we divide it up into twelve equal parts of $\frac{37.699}{12} =$

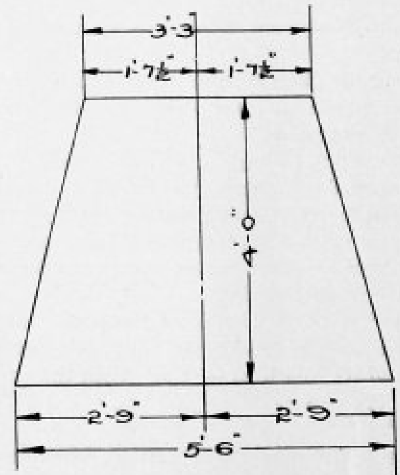


FIG. 9.

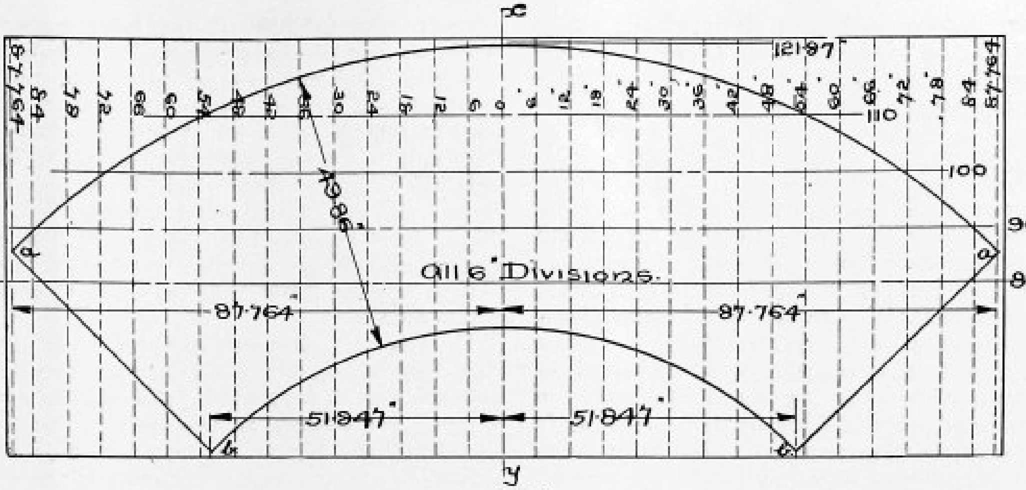


FIG. 10.

3.146 inches, as shown in Fig. 6. Now strike the line *x-x* at a distance of *H* from the edge of the plate x_1-x_1 equal to the dimension *M*, and x_2-x_2 equal to the dimension *N* from each other. Number up the divisions as shown in the figure.

Having found the value of *H* (for the top part of the pipe) on the chart, which is 4.95 inches, we read off the following values for the various divisions from the chart, Fig. 4:

Division No.	6	5	4	3	2	1	0
	4.95	4.62	3.71	2.475	1.24	.33	0

These can be figured on the plate as seen in Fig. 6, and afterwards marked thereon. The line *x-x* is the "base" line from which to mark off these values.

With reference to the "lower" part of the plate. In this case we have two distinct values for *H*. In the first case we

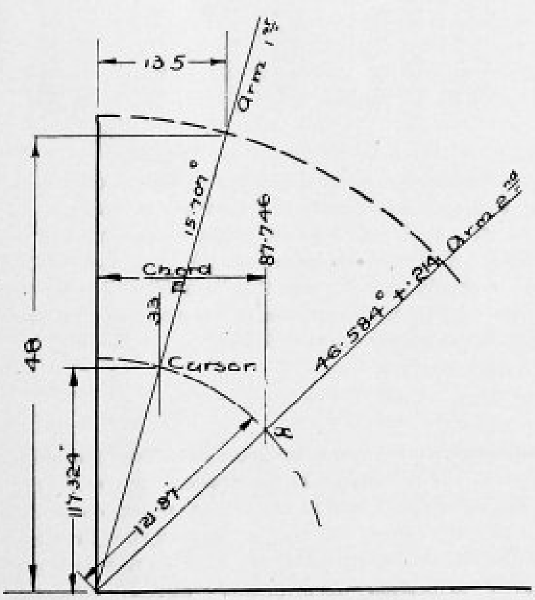


FIG. 11.

get a value of 12 inches, and in the second 5 inches, the first passing through the ordinates 3-4-5-6-5-4-3, and the second through the ordinates 3-2-1-0-1-2-3. We need only consider the three lower curves of Fig. 4 in making this part of the layout.

It will be noticed that for reading off the values, when $H = 12$, we read off in position 1.2, simply shifting the decimal or multiplying by 10, but the values on the vertical scale must be served in like manner. For this we read off as follows:

Position	6	5	4	3
Value read	0"	.0804"	.3"	.6"
Real value	0"	.804"	3"	6"

These values are to be marked off with the line *x x* as a base.

In the second case when $H = 5$ inches we read off the following values:

Position	0	1	2	3
Value for ordinates	0	.335	1.25	2.5

Having marked these points on the plates, add the proper amount for lap, etc., and draw in the line.

In the case of the lower pipe of the connection we get two values of *H*, which are both alike, and as the above procedure has made the method to be followed quite clear, it is not intended to take up valuable space in a description of same.

The next chart which we have to consider will be found very useful for several purposes, and if care is taken in the construction no inaccuracies should creep in. This chart is shown in Fig. 7, and although the relative parts are not to scale, yet the idea will be easy to grasp. It consists of centimeter paper ruled into tenths the size, 52 by 52 centimeters square. This is to be fixed permanently to a nice board, previously having had the radial and arc lines marked upon it as shown, the outer arc being divided up into degrees and then each degree is to be divided up into .2 degree. We require now an arm of hardwood about 53 centimeters long, to which we fix a scale (white celluloid) marked into divisions of 1/10 centimeter, this arm having grooves for carrying a metal cursor, made to the shape shown (Fig. 8). The divisions for this scale have to commence at point *o*. The edge of the scale will also have to be in line with this pin hole. Through this hole a pin has to pass to enable the arm to be shifted over the chart to any desired position, turning about the origin *o* of chart on the pin.

USE OF CHART TO LAY OUT A CONE FRUSTUM.

Suppose we have to lay out the frustum shown in Fig. 9. We proceed as follows: We need only consider the half figure or the radii of the two circles (top and bottom), which equal 33 and 19½ inches, and give us a taper of 33 — 19½ = 13½ inches. Move the arm of the chart round, so that it coincides with a reading of 13½ inches on the top scale and 48 inches on the vertical scale, as seen on Fig. 11. Now slide down the cursor till it points to 33 on the top scale. Running along the chart horizontally to the vertical scale, we read off 117.324 inches, which is the height of the cone to the apex; simultaneously, we read off on the arm scale 121.87 inches, the radius of the circle. On the degree scale read off the number of degrees which equals 15.707 degrees. It will be found that the total number of degrees in the development is equal to .360 times the sine of the number of degrees in the cone, or since we are only considering half the cone we have:

$$180 \times \text{sine } \theta \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where θ = number of degrees in cone divided by two.

The appended table enables the total degrees for the half development to be quickly found: Opposite 15 degrees we find 46.584 and a difference of .3024 per 1 degree; then $.707 \times .3024 = .214$. Adding $46.584 + .214 = 46.798$. We now move the arm to this number of degrees on chart. Where the cursor now points gives us 87.746 inches, which is the half chord for the arc we require, and which is read off on the top scale. To mark the plates, refer to Fig. 10; first mark off the line *xy* in the center. At the point *x* the curve is at its maximum height, which equals 121.87 inches. At 11.87 below this we have the 110-inch line, and at spaces below this of 10 inches each we have the lines marked 100 inches, 90 inches, 80 inches. The lowest line will always be to the nearest even ten below that found on the chart of Fig. 11 at *x*, the cursor setting. These lines should be struck on the plate at right angles to the *xy* line. Now divide up the plate on each side of the center line into a convenient number of parts of, say, 2, 4, 6 or 8 inches apart. In our case 6 inches has been chosen. Make the outside line at a distance of half a chord = 87.714 inches from the center line. These vertical lines may be numbered with the number of inches they are from the line *xy*, as 6, 12, 18, 24, 30 and so on. Now all that remains to be done is to read off from our chart on the vertical scale the values for our ordinates by moving the arm around to the left, stopping to make a reading as the cursor points to the ordinates 87.746 inches, 84 inches, 78 inches, 72 inches, 66 inches, 60 inches, and so on down to zero. These values may be figured on the plate first and then marked off in a similar manner to the previous development. It should be noticed that once the cursor is set it is not necessary to touch it again for the same example.

The lower curve may be marked out simply obtaining the half chord of the other arc by resetting the arm at 46.798 degrees, and shifting the cursor down to where we read $117.324 - 48 = 69.324$ inches on the vertical scale. We read off 51.847 as the value of the half chord. Marking these distances on the plate, set the chart arm with 48 on vertical scale and 13.5 on the top scale, reading off 49.86 inches on the arm. Now set the trammels to this and with center (*a*) strike arc through line at (*b*) Fig. 10. Now join points *a* and *b*. Divide up arc *a a* into any convenient number of parts, and from the points so found strike a series of arcs with the trammels in the vicinity of arc *b b*. Strike around these arcs so that we shall have the same number of divisions in arcs *a a* and *b b*. Now draw in the lines, which complete the layout.

It will be noticed that in both charts the maximum value is 10. We read off at the same place for, say, 8, .8, 80, etc. But it should be noticed that when we multiply or divide the horizontal scale figure by 10, we also do likewise to the vertical scale, so that it is not necessary to have a chart for values over 10.

There is a considerable number of other applications for this chart, but space forbids entering into details of same, although a good many will be obvious after using the chart a little. For instance, all trigonometrical problems may be solved with accuracy and rapidity, and I hope at some future time to give more examples of the use of this chart, as I believe that it is one of the most useful "tools" that a layer-out could have.

Providing the laying out is always done in a systematic way, no errors or inaccuracies are likely to turn up, and the chart will soon pay for itself several times over.

The idea, so far as I know, is quite original, and I do not think that such methods have been adopted in any other boiler shop. I should also say that this "graph" will serve the same purpose of Fig. 4, if positions are marked on the outside arc to coincide with the curves of Fig. 4.

TABLE OF VALUES FOR 180 × SIN θ.

Deg.	Value of Sin.	180 × Sin θ.	Diff. per .1 Degree.	Deg.	Value of Sin.	180 × Sin θ.	Diff. per .1 Degree.	Deg.	Value of Sin.	180 × Sin θ.	Diff. per .1 Degree.	Deg.	Value of Sin.	180 × Sin θ.	Diff. per .1 Degree.
1	.0175	3.15	.3132	24	.4067	73.206	.2862	47	.7314	131.652	.2106	69	.9336	168.048	.1098
2	.0349	6.282	.3132	25	.4226	76.068	.2844	48	.7431	133.758	.2088	70	.9397	169.146	.1044
3	.0523	9.414	.3150	26	.4384	78.912	.2808	49	.7547	135.846	.2034	71	.9455	170.19	.1008
4	.0698	12.565	.3150	27	.4540	81.72	.2790	50	.7660	137.88	.1998	72	.9511	171.198	.0936
5	.0873	15.714	.3096	28	.4695	84.51	.2754	51	.7771	139.878	.1962	73	.9563	172.134	.0900
6	.1045	18.81	.3132	29	.4848	87.264	.2736	52	.7880	141.84	.1908	74	.9613	173.034	.0828
7	.1219	21.942	.3114	30	.5000	90.00	.2700	53	.7986	143.748	.1872	75	.9659	173.862	.0792
8	.1392	25.056	.3096	31	.5150	92.70	.2682	54	.8090	145.62	.1836	76	.9703	174.654	.0738
9	.1564	28.152	.3096	32	.5299	95.982	.2646	55	.8192	147.456	.1764	77	.9744	175.392	.0666
10	.1736	31.248	.3096	33	.5446	98.028	.2628	56	.8290	149.22	.1746	78	.9781	176.058	.0630
11	.1908	34.344	.3078	34	.5592	100.666	.2572	57	.8387	150.966	.1674	79	.9816	176.688	.0576
12	.2079	37.422	.3078	35	.5736	103.228	.2576	58	.8480	152.64	.1656	80	.9848	177.264	.0522
13	.2250	40.50	.3042	36	.5878	105.804	.2520	59	.8572	154.296	.1584	81	.9877	177.786	.0468
14	.2419	43.542	.3042	37	.6018	108.324	.2502	60	.8660	155.88	.1548	82	.9903	178.254	.0396
15	.2588	46.584	.3024	38	.6157	110.826	.2448	61	.8740	157.428	.1512	83	.9925	178.65	.0360
16	.2756	49.608	.3024	39	.6293	113.274	.2430	62	.8830	158.94	.1440	84	.9945	179.01	.0306
17	.2924	52.632	.2988	40	.6428	115.704	.2394	63	.8910	160.38	.1404	85	.9962	179.316	.0252
18	.3090	55.62	.2988	41	.6561	118.098	.2340	64	.8988	161.784	.1350	86	.9976	179.568	.0180
19	.3256	58.608	.2952	42	.6691	120.438	.2322	65	.9063	163.134	.1296	87	.9986	179.748	.0144
20	.3420	61.560	.2952	43	.6821	122.76	.2286	66	.9135	164.43	.1260	88	.9994	179.892	.0072
21	.3584	64.512	.2916	44	.6947	125.046	.2232	67	.9205	165.69	.1206	89	.9998	179.964	.0036
22	.3746	67.428	.2898	45	.7071	127.278	.2196	68	.9272	166.896	.1152	90	1.0000	180.000	.....
23	.3907	70.326	.2880	46	.7193	129.474	.2178								

Convention of Smoke Inspectors.—The fifth annual convention of the International Association for the Prevention of Smoke, an organization of the smoke inspectors of American and Canadian cities, was held at Minneapolis June 29 to July 1, inclusive. About fifteen cities were represented by officials of their inspection departments. Special appliances and methods of furnace construction for avoiding smoke received the major part of the attention at the sessions. A discussion advocating the electrification of railroad terminals as a preventive of much of the smoke in large cities and railroad centers was led by the smoke inspectors of Chicago and Milwaukee. Following the technical sessions of the association, Mr. Paul P. Bird, smoke inspector of the city of Chicago, was elected president and Mr. R. C. Harris, Commissioner of Properties of Toronto, Can., was chosen secretary and treasurer.

MARINE BOILER CONSTRUCTION.

BY JOHN GREEN.

There are at least four distinct classes of marine boilers now in use, each of which may be sub-divided in various ways; for convenience' sake we may class them as follows:

1. The wet-bottomed cylindrical boiler with return tubes, made for pressures up to 225 pounds per square inch.

2. The locomotive type boiler, having tubes extending in line beyond the fire-box, or combustion chamber, made for pressures up to 200 pounds per square inch.

3. The tubulous boiler, composed wholly of large, straight, or nearly straight, tubes and their connections, made for pressures up to 300 pounds.

4. The watertube boiler, having small, straight or bent tubes, for pressures up to 250 pounds per square inch.

It is the first of these classes that we wish more particularly to consider, as it was the demand for the higher pressures which became possible after the introduction of the surface condenser that brought the cylindrical boiler into general use, and this type probably stands at present unrivaled so far as efficiency, reliability and durability are concerned.

There are several varieties of cylindrical boilers in use, viz.: single-ended, double-ended and the oval boiler. The single-ended boiler has furnaces and tubes at one end only, and is constructed up to as large as 17 feet diameter and 12 feet long. The chief difficulty in large boilers of this type is to provide adequate grate area for the total heating surface which can be obtained. The number of furnaces cannot well exceed four, and is more generally three, in this type of boiler; the number and size of the furnaces depend, however, on the size of the boiler and the heating surface it is to contain. It has been found in practice that large furnaces are more efficient fuel burners than small ones, and the reason is not far to seek. The grate area with the same length of fire bar increases as the diameter, while the section through which the air passes, both above and below the bars, increases as the square of the diameter; it is also possible to give a good inclination or rake to the bars with a large furnace, which materially assists combustion. In practice the fire-bars are not, of course, always of the same length, but they do not increase in length as the furnace does in diameter, and consequently the air passages increase more rapidly than does the grate area when the diameter of furnace is increased.

Furnaces should not be less than 36 nor more than 48 inches in diameter except under special circumstances. Taking this as a rule for guidance, boilers may be made up to 9 feet diameter with one furnace, up to 13 feet 6 inches diameter with two furnaces, up to 15 feet with three furnaces, and beyond that diameter four furnaces are necessary to avoid too long a length of grate. It ought to be said here, however, in passing, that it is unusual and certainly very difficult to use plates above 1½ inches thick in the construction of a boiler shell, and it is this consideration which fixes the limit of diameter.

The double-ended cylindrical boiler has furnaces at both ends with return tubes over them, and is, generally speaking, two single-ended boilers back to back, but with the backs removed. It is made up to 16 feet diameter and as much as 20 feet long; this type of boiler is lighter and cheaper in proportion to the total heating surface than the single-ended, and its evaporative efficiency in practice is generally higher. On the other hand, greater care is necessary in designing and in working it.

The simplest form of this kind of boiler is one in which all the furnaces open into one common combustion chamber; this form, although at one time common enough, is now seldom adopted, owing to the fact that the bursting of one tube may disable the whole boiler; that the cleaning of one fire causes the efficiency to sink very low, on account of the whole being affected by the inrush of cold air, and unless special means be provided to promote proper circulation there is a strong tendency to prime.

There have been various means introduced to obviate these objections, such as building a thin brick wall of special brick across the middle of the combustion chamber, and another method is to divide the combustion chamber longitudinally by water spaces; but none of them have proved entirely satisfactory. It is often urged against this form of boiler that the tubes are very liable to leakage at their back ends, arising from the rush of cold air against the tube plate when the door of the furnace opposite it is open, causing it to buckle; it sometimes happens that the tubes in this kind of boiler show a tendency to leak, but it is then generally due to the want of expansion on the part of the first row of stays above the combustion chamber when they are placed too close to the tubes. If these stays are at least 12 inches above the tubes, so as not to hold the front tube plates too rigidly, then when steam is being raised the expansion of the tubes simply causes the plates to spring very slightly, instead of starting their ends and causing them to leak. The leakage from springing of the tube plate from exposure to cold air can only take place when the combustion chamber is unduly short, and when there is an insufficient number of stays to the tube plates. Common care only is required in raising steam, and the opening of fire-doors to check evaporation is a reprehensible practice at all times and for all boilers.

Another form of the double-ended boiler is one in which each furnace has an independent combustion chamber; this is now almost always adopted, although it is by far the most expensive and heaviest type.

The amount of grate area is the consideration which chiefly affects the dimensions of a boiler, and to a very large extent the number of boilers necessary are governed by it. To increase the number of furnaces in a cylindrical boiler the diameter must be increased, which means that both breadth and height are effected. Two furnaces of 40 inches diameter are the limit for a boiler of 10 feet diameter, that there may be adequate heating surface, and 14 feet is the suitable diameter for three furnaces of 40 inches diameter, the grate-bars being of the same length in both cases, the increase in boiler capacity is 96 percent for an increase of 50 percent of grate. The smallest diameter of shell into which three 40-inch furnaces can be fitted so as to give adequate heating surface is 13 feet 6 inches, which is an increase in capacity of 82 percent over the boiler 10 feet in diameter. Four 40-inch furnaces require a shell of at least 16 feet diameter, which means an increase of 156 percent to obtain 100 percent increase of grate. To some extent increase of grate area may be obtained by increasing the length of furnace, but the efficiency of the grate in practice is nearly inversely as its length, for a long grate cannot be nearly so well attended to as a short one, nor is the air supply either under or over the bars so good with a long furnace, since the area of section at the mouth with the same diameter of furnace is the same whether the bars be short or long.

It has been found correct in every-day practice that the consumption of coal is very nearly proportional to the diameter of the furnace. The area of fire grate required for the evaporation of a certain weight of steam depends on the quantity and quality of the fuel burned on it; and the quantity is generally dependent to a large extent on the quality and the draft. It may be asumed that 1 pound of good steam coal will evaporate 10 pounds of water in the ordinary marine boiler, also that in the mercantile marine, where the coal is only of moderate quality, 8 to 9 pounds is a fair result, and only 6 to 8 pounds can be obtained with the coal supplied in some foreign ports. The quantity of coal burned on a square foot of grate per hour with natural draft is about 20 pounds under favorable circumstances; with good stoking on special bars and with very good draft as much as 25 pounds may be consumed. But under ordinary circumstances and natural draft only 15 pounds should be supplied to obtain complete combustion and economical results. With Howden's system of forced draft and warm air 50 pounds per square foot can be burned if the coal is fairly clean and good; with closed stokehold and an air pressure of ½ inch of water from 30 to 35 pounds of good coal can be burned. From this it can be calculated that the greatest weight of steam evaporated per square foot of grate per hour under favorable circumstances and natural draft is 10 × 25, or 250 pounds; with poor fuel and economical stoking it may be only 6 × 15, or 90 pounds; with fairly good fuel and favorable circumstances it may be 9 × 20, or 180 pounds, or with fair coal and careful stoking about 150 pounds may be expected. In practice, therefore, for short trips with good coal and good stoking, calculations may be based on 250 pounds; for mail steamers using good coal 150 pounds for natural draft, and for forced draft from 270 to 380, depending on the air pressure. If the ship is to trade in localities where inferior coal is to be used the boilers should be constructed on the assumption of an evaporation of only 100 pounds of water per square foot of grate for natural and 200 to 280 for forced draft. The weight of steam required per hour for a given engine may be calculated, and divided by one of the foregoing numbers suitable to the case, the result will be the number of square feet of grate surface required.

As the consumption of coal per indicated horsepower per hour with good triple-expansion engines is 1½ pounds, and assuming the grate to burn 15 pounds per square foot, there should be 0.1 square foot of grate per indicated horsepower; if, therefore, the sea full speed indicated horsepower of a steamer be multiplied by 0.1, the result is the grate area required for that power.

There should be about 1.33 square feet of iron tube for every pound of coal burned per hour; that is, in the ordinary marine boiler there should be about 27 square feet of tubes per square foot of grate. The ratio of tube surface to the total heating surface is about 0.8 in the single-ended to 0.88 in the double-ended cylindrical boilers. The following rule gives approximately the amount of total heating surface which a cylindrical boiler may have:

Total heating surface = (diameter of shell in feet)^2 × (length of tubes in feet + 3). The sectional area through the tubes, or that area through which the hot gases and smoke pass from the combustion chamber to the funnel, should not be less than one-seventh the area of grate with natural draft, and it is usually about one-fifth. Too large an area produces a slow velocity, which permits a deposit of soot and ash, with the consequent reduction of evaporative efficiency. Too small an area checks the draft, especially when the surfaces have become dirty. With forced draft the area through tubes can be smaller if necessary, and when it is more than one-seventh the grate (for natural draft) it is advantageous to have retarders in the tubes; these spiral strips not only prevent a too rapid flow of gas, but force the hot current over every portion of the tube.

To contain the requisite heating surface, and to have sufficient steam space the boiler should contain 3 cubic feet per indicated horsepower for the merchant service, although sometimes a slightly larger allowance is made, especially for steamers making long voyages.

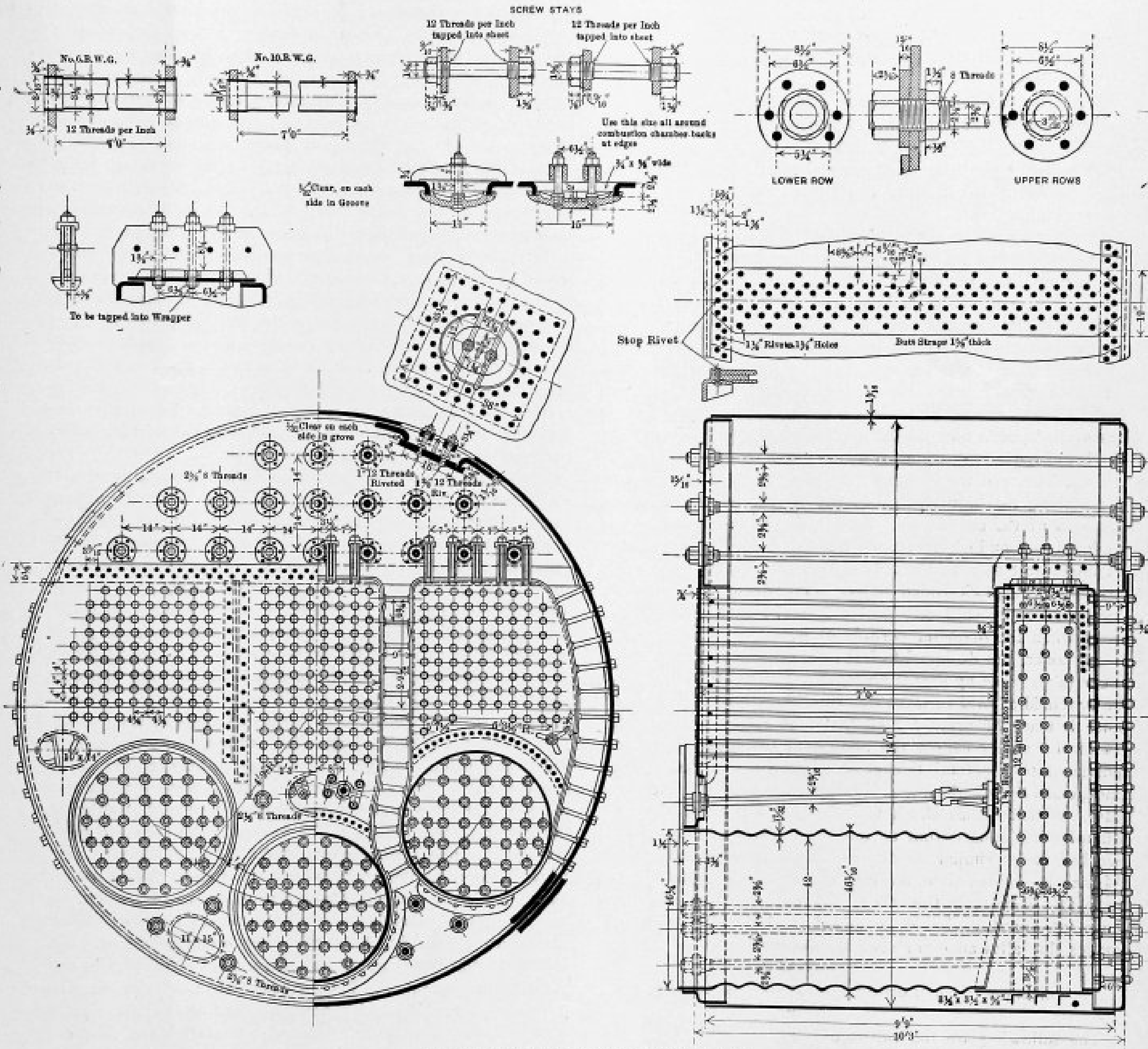
The "volume" of steam produced at a pressure of 210 pounds being only about one-third that at 70 pounds when the same weight is used, the steam space for boilers working at the high pressures now obtaining may be considerably less than was formerly usual. Good results can be got now with an allowance of 1¾ to 2 cubic feet of boiler per indicated horsepower for natural draft, and 1¼ to 1½ for forced draft. The steam space, however, must bear a relation to the high-pressure cylinder capacity in every case; the intermittent demand of the single high-pressure cylinder of a paddle engine effects the equilibrium of the boiler very differently from that of the two high-pressure cylinders of a twin-screw ship, running at four times the revolutions, but using the same quantity of steam.

The top row of tubes in a cylindrical boiler should be not less than 0.28 of the diameter of the shell from the top. The tubes are sometimes placed higher, but there is then a risk of priming from contraction of water surface area as well as from the conformation of the sides; priming is oftener due to this cause than to small steam space, although the latter is generally set down as the cause when the tubes are high.

The capacity of the steam space depends on the quantity of steam used in a fixed time, and on the number of periods of supply to the engines in that time; the effect of opening to the cylinders is to reduce the pressure in the steam space, and if the reduction of pressure be sensible there will be augmented ebullition at that period. If the reduction in pressure is serious there will be excessive ebullition resulting in priming. There should be 0.8 cubic foot of steam space per indicated horsepower for a slow-running paddle engine, and 0.65 cubic foot per indicated horsepower for compound-screw engines, and as low as 0.55 cubic foot for fast-running engines. Boilers for triple-expansion engines may have 25 percent less steam space than this with natural draft, and 40 percent less with fast-running ones and forced draft. The amount of steam space in a boiler is not dependent on the weight of steam used per stroke, but on the volume, and for that reason a boiler constructed for, say, 200 pounds pressure does not require so much steam space as a similar boiler constructed for only 75 pounds pressure; for if both boilers have the same grate area and heating surface they will evaporate the same weight of steam, but the volumes will be as 3 to 8 nearly; if these two boilers supply steam at the same rate to engines running at the same number of revolutions their steam spaces may be as 3 to 8 nearly. The sectional area of the funnel should be from one-fourth to one-sixth that of the grate, in general practice one with a sectional area of one-fifth to one-sixth that of the grate, and whose top is at least 45 feet above the grate level will give a very good result; when the draft is forced either by a blast or by other artificial means the funnel may be shortened, and of comparatively small diameter. A rough rule gives the sectional area for merchant steamers with natural draft, viz.: 1.25 square inches for each pound of fuel consumed per hour, or, say, 1.88 square inches per indicated horsepower at full speed.

Marine boilers are nearly always constructed in accordance with specific rules laid down for the scantlings and to meet the requirements of the Board of Trade, United States Steamboat Inspection, Lloyd's or other registry (see Synopsis of Boiler Construction Regulations, page 265). It is regrettable that these institutions do not agree to one set of rules which would be acceptable to all and be in accordance with the best engineering knowledge and experience of the times. These rules, however, are based on practical experiments carried out on a large scale and on scientific principles, and they differ chiefly on the question of the factor of safety, the differences on this point arising from the allowances included for wear and tear. The Board of Trade requires that the steel used in boiler sheels have a minimum strength of 27 tons and a maximum of 32 tons per square inch, with an elongation of not less than 18 percent in 10 inches, and an allowance of 28 tons to be used for calculations. They require, however, a minimum factor of safety of 4.5, which is quite sufficient, considering that the stress on the material is gradually and gently applied and is quite steady during the work.

The longitudinal seams or joints of a boiler shell are made in several different ways, viz.: 1. Lap joint and single riveted; lap joint and double riveted; lap joint and treble riveted. The chief difficulty with lap joints is the working of the corners of the plate, where the next strake of plating covers the lap; these corners are hammered to a taper so as to nearly conform to a circle, and the covering plate is slightly joggled, so as to lie evenly on the deformation caused by the lapping. Some boiler makers to ensure a good fit go to the expense of planing or milling the corners fair, and even to extend the taper part beyond the butt end of the plate itself, so as to cause as little deformation as possible. With a lap joint, treble riveted "zigzag," a strength of joint of 72 percent can generally be obtained with a rivet area equal to that of the plate between the holes; by arranging the rivets so that there is half the number in each edge row that there is in the middle row, the strength of joint may be as much as 85 percent. 2. Butt joints with double straps and single riveted; this form of joint is but seldom resorted to, as its strength is not often more than 65 percent of the solid plate; greater strength cannot be obtained without placing the rivets so far apart as to prevent the straps from being calked tight. If, however, the straps are made of the same thickness as the plate itself, 70 percent can be obtained. 3. Butt joints with double straps and double riveted; this is a general and deservedly favorite form of joint for thick plates, and when well made gives every satisfaction; there is no necessity for smithing or machining the plates, nor of joggling the covering plate of the next strake, although some boiler makers, to avoid the calking of the ends of the strap where it butts against the next strake, thin down the end and notch out the covering plate, so as to lap over the strap; this makes a very good joint but is somewhat expensive. 4. Butt joints with double straps, treble riveted; this form of joint has become a necessity, since very thick plates have been used for boiler shells in order to get an adequate sectional area of rivet; it also admits for the same reason of thinner plates being used



THREE-FURNACE, SINGLE-ENDED SCOTCH BOILER.

when desired, so that when there are only a few butt joints it is really more economical to adopt this form. In this case, for each portion of plate between the holes, there is a rivet area equal to six times the area of section of one rivet; the percentage of plate between the rivets is generally 80 percent with this type of joint, and in practice the rivets are never less in diameter than the thickness of the plate. The circumferential seams are almost always lapped and double riveted; boilers of small diameter and for comparatively low working pressures are single riveted, and, as one row of rivets is quite sufficient to secure tightness of joint, the single-riveted joint might be adopted more generally than now obtains in single-ended boilers.

Formerly the holes in boiler plates were punched and drifted fair, but now drilling machines have been introduced which compete successfully both in the cost and speed of the work with the punching machine, and all the holes in a boiler shell can be drilled in place at a trifling expense beyond that of punching.

In selecting plates for a cylindrical shell it is necessary to bear in mind that tensile strength and moderate elasticity are the two qualities requisite; Siemen's steel has now taken the place of iron in boiler making, and as it possesses a much higher tensile strength, together with greater elasticity, it is a more suitable material for the purpose. A boiler made completely of steel is also cheaper than one made wholly of iron, which no doubt is one cause of the increased demand for steel boilers. The size of plates to be used in the construction of the shell depends now on the appliances of the boiler maker; the breadth of plate is limited by the depth of gap in the riveting machine, and the length of the plate by the capabilities of the planing machine and rolls; the weight is limited to the strength of the cranes, etc. Steel makers can produce plates 12 feet broad and of almost any length. A double-ended boiler of the largest size can be made in three drums, and each drum in two plates, single-ended boilers in one drum or two if very long, and some engineers prefer to make each drum in one plate when the diameter permits of it.

All boilers are designed to last as long as possible, but since wear takes place by corrosion some additional thickness must be provided at first to meet this condition; tacitly, this allowance is made by using a high factor of safety, but since the factor of safety causes the additional thickness to be proportional to the total thickness, while the wear takes place independently of thickness, it does not properly meet the case. A boiler with plates ½ inch thick will waste the same quantity per square foot as one with plates 1 inch thick if worked under similar conditions. Suppose such waste to be ⅛ inch in a given time, the loss in one case is 25 percent but only 12½ percent in the other. To meet the case properly a constant quantity should be added, and the following rule makes due allowance for such contingencies:

$$\text{Thickness of shell plate} = \frac{D \times p}{F} + \tfrac{1}{8} \text{ inch.}$$

The following are the values of F:

Lap joints, single riveted	16,000
Lap joints, double riveted	21,000
Lap joints, treble riveted	22,000
Butt joints, double riveted, double straps	22,000
Butt joints, treble riveted, double straps	26,000

D, the diameter of the shell in inches; p, the working pressure in pounds per square inch.

The almost universal method of connecting the boiler ends to the shell is by flanging the end plates, and this is the best plan, as there are only one set of rivets and two calking edges. Flanging is done by special appliances at small cost in various designs of hydraulic press. Some few engineers, however, in order to provide a thicker plate to withstand the wear that takes place at the bottom edges of the cylindrical boiler, and to avoid the fitting of the flanged ends into the shell with fair accuracy, flange the shell plates inwards, so as to form a connection for the ends.

This has some bad features, among which may be mentioned the difficulty and cost of flanging thick plates across the grain, especially after being bent; the necessity of such shell plates to be of low tenacity to have so much ductility, and the pressure on the end always tending to open the seams. The quality of the end plates depends largely on the amount of flanging to be done. To stand flanging around the edges of the circular plates they may be of the same quality as the shell, but when the furnace holes are flanged to meet the furnaces a softer quality is necessary, and it is better to use the same as that usual for internal parts with an extension of at least 25 percent to stand such severe treatment. The thickness of the end plates and the pitch of the stays are interdependent to a certain extent; but, since the stays in the upper part of the boiler must be wide enough to permit a man to pass between them, the plates at the upper part of the ends must be thick enough to suit this pitch of the stays, which are usually in consequence thicker than the other part of the ends. Some makers, however, prefer to make the ends of one uniform thickness, and stiffen the top plates to stand the wide pitch of the stays by riveting on large, thick washers in wake of these stays. Taking 15 inches as the smallest convenient pitch for the stays in the steam space, and they having riveted washers as well as double nuts, Lloyd's requires the plate to be 13/16 inch thick for 150 pounds working pressure and 15/16 inch thick for 200 pounds.

Furnaces fitted in a cylindrical boiler are invariably of circular section, that being the best form to resist a uniform external pressure; the strength of such a furnace varies as the square of the thickness of the plate, and inversely as the diameter and length; furnace plates are made from ⅜ inch to ¾ inch thick, the most general sizes being 7/16 to 9/16 inch. Some engineers, however, to avoid using corrugated furnaces or fitting stiffening rings, make the furnace of plates as thick as ⅞ inch. If the furnace is so long that 9/16-inch plates are insufficient by the rules for the working pressure, some means of stiffening it should be resorted to. The stiffening is generally effected by means of rings secured to the plates, and the effective length for purposes of calculation is the longest distance between such rings, or between such rings and the ends. Corrugated furnaces have become practically a necessity for large diameters and high pressures, but although immensely strong as long as the metal is cold, they will probably collapse longitudinally when red hot quicker than an ordinary furnace, as the corrugations are simply drawn out of shape, while the common furnace cannot come down without stretching the metal between the points of support. When plain furnaces are fitted the plates are better joined by welding, and with proper appliances there is little difficulty in performing this operation. The next best form of joint for plain furnaces is the butt with double straps and single riveted, and this was the method adopted when steel was first employed.

The length of the combustion chamber, measured in line with the furnace, should be such that its capacity above the level of the fire bars is equal to the total capacity of the furnace when the boiler is single ended; when double ended and one combustion chamber is common to opposite furnaces, its capacity should be equal to three-fourths of the combined total capacity of the two furnaces. To obtain this combustion chamber capacity, when the boiler is single or double ended and the chamber divided transversely, the length must be about two-thirds the diameter of the furnace, and when common to two opposite furnaces it must be nearly equal to the diameter of furnaces.

The thickness of plates and pitch of stays are, of course, interdependent; but as a rule the chambers of large boilers whose working pressure is 150 pounds per square inch and upwards are made of ½-inch to ⅝-inch plates, and those of smaller boilers, or those working at lower pressures are made of 7/16 to ½-inch plates. A plate ½ inch thick requires a stay for 7.75 inches pitch or 60 square inches at a pressure of 150 pounds, while a ⅝-inch plate requires one for 9.3 inches pitch, or 86 square inches for that pressure, the stay-bars being 1⅜ inches diameter, screwed ten threads to the inch. The bottom of the chambers should be ⅛ inch thicker than the sides, as from various causes there is often wear in that part, also to avoid excessive staying and to provide for burning which sometimes takes place there, the plates at the top should be 1/16 inch thicker. Generally the back tube plate in modern boilers of ordinary sizes and pressures is ⅝ to ¾ inch thick, the former being the best size when possible, as with it the tubes can be made quite tight, and there is less liability of cracking the plates or burning the tube ends than with the thicker plates.

The tubes are generally from 2½ inches to 4 inches external diameter, the usual sizes being from 2½ to 3½ inches for ordinary boilers in the mercantile marine, and with natural draft they should not be more than 25 diameters long; with forced daft the length may be as much as 50 diameters. The spacing depends on circumstances, but the pitch is usually 1.4 times the diameter. There is less liability to prime when the tubes are widely spaced, and they are more easily cleaned from scale; for the latter purpose they are arranged in rows, both horizontally and vertically.

Tubes are manufactured of a certain minimum thickness, but the gage must necessarily depend upon the working pressure. It is usual to make the front end of the tubes of slightly larger diameter (1/16 to ⅛ inch), so that they may be drawn out easily when once started from the plates. Boiler tubes are usually made of iron, lap welded, but steel tubes

SYNOPSIS OF BOILER-CONSTRUCTION REGULATIONS.

	British Board of Trade.	British Lloyds.	United States Statutes.	Bureau Veritas.
Hydraulic test.........	Twice working pressure.	Twice working pressure.	One and one-half times working pressure.	Twice working pressure.
Factor of safety........	4.5	Between 4 and 5.	5 to 6 prescribed by law. About 3.5 to 4.7 in rules.	4.4
Material for rivets......	*T. S.* 52,000 to 60,000 lbs. Elong. at least 25 percent in 10 inches. Contraction of area at least 10 percent.	*T. S.* 52,000 to 60,000 lbs. Elong. at least 20 percent in 8 inches. Quench strips must bend 180° around diameter.	None.	*T. S.* 53,000 lbs. Temper test same as British Lloyds.
Rules for riveting......	*S. S.* 46,000 lbs. rivets on double shear to count only 1.75 times single section. Diameter of rivets at least *t*. Center of rivet to edge plate $= \frac{\text{Diam. rivet} \times 3}{2}$ Distance between rows, if chain $= 2 \times$ diameter rivets, or $\frac{\text{Diam.} \times 4 + 2}{2}$ if zigzag $= \frac{\sqrt{(\text{pitch} \times 11) + (\text{diam.} \times 4) + (\text{pitch} + \text{diam.} \times 4)}}{10}$ Diagonal pitch $= \frac{(\text{pitch} \times 6) \times (\text{diam.} \times 4)}{10}$	Rivets in double shear to count only 1.75 times single section. *S. S.* 85 percent of *T. S* of plates. Where experiments have been made these strengths may be used.	None.	*S. S.* when assumed, to be .8 *T. S.* of plates. At working pressure *S. S.* to be $\frac{1}{4.4}$ part of full *S. S.* Double shear twice single section. Value of rivet section modified by character of hole and kind of riveting. Circular seams to be double riveted if plates exceed ½ inch.
Material for shells......	*T. S* 54,000 to 64,000 lbs. Elong. at least 18 percent. Strips 2 inches wide must bend 180° over diameter = 3*t*.	*T. S.* 52,000 to 60,000 lbs. Elong. 20 percent in 8 inches. Strips must bend 180° over diameter = 3*t*.	Contraction of area 40 to 50 percent for various thicknesses. Elong. 25 percent in various lengths from 2 inches to 8 inches in thickness from ¼ inch upward.	*T. S.* not over 61,000 lbs. Elong. 20 to 31 percent for various *T. S.* Strips must bend 180° around diameter = 3*t*.
Plates for flanging......	*T. S.* 52,000 to 60,000 lbs. Elong. 20 percent in 10 inches. Strips must bend 180° around diameter = 3*t*.	*T. S.* not over 56,000 lbs. Elong. at least 22 percent. Strips must bend 180° around diameter=3*t*.	Contraction of area 40 to 50 percent dependent on thickness of plate.	*T. S.* not over 61,000 lbs. Elong. 20 to 31 percent for various *T. S.* Strips must bend 180° around diameter = 3*t*.
Shell-plate formulæ.....	$P = \frac{T \times B \times t \times 2}{D \times F \times 100}$ *P* = working pressure. *t* = thickness in inches. *T* = *T. S.* allowed. *D* = diameter shell. *F* = *F. S.* = 4.5 + additions depending on character of joints and holes. *B* = percent of joint to solid plate, or plate or rivets whichever is least.	$P = \frac{c \times (t - 2) \times B}{D}$ *c* = constant varying from 18.5 to 20 depending on kind of joint.	$P = \frac{t \times 2 \times T}{D \times 6}$ for single riveting. $P = \frac{t \times 2 \times T}{D \times 5}$ for double riveting. No allowance for value of seam.	$P = \frac{T \times B \times (t - 0.04)^2}{D \times 4.4 \times 100}$ *B* = percent of plate section at joint. *P* also depends on rivet section.
Rules for flat plates....	$P = \frac{c(t + 1)^2}{s - 6}$ *s* = surface supported in square inch. *t* = thickness of plate in sixteenths *c* = factor depending on exposure and methods of support. Varies from 66 to 200.	$P = \frac{c \times t^2}{p^2}$. $P = \frac{c \times (t \times d)^2}{p^2}$ *c* = factor depending on method of supporting plates. Varies from 90 to 240. *d* = thickness of doubling plates in sixteenths.	$P = \frac{C \times t^2}{p^2}$ *C* — as in British Lloyds. Varies from 112 to 200.	$P = \frac{(t - 1)^2}{a^2 + b^2} \times \frac{T}{C}$. *T* = *T. S.* in tons per square inch. *a* = pitch in one row in inches. *b* = distance between rows. *C* = factor depending on method of supporting and varies from 0.055 to 0.084.
Material for stays......	*T. S.* 54,000 to 64,000 lbs. Elong. at least 20 percent in 10 inches. Steel stays must not be worked in fire.	*T. S.* 52,000 to 60,000 lbs. Elong. at least 20 percent in 8 inches.	For steel, must bend 180° around diameter = 3*t*.	Same as for shell-plates.
Load allowed on stays..	9,000 lbs. per square inch on net section, if *T. S.* lies between 54,000 and 64,000 lbs.	Stays under 1½ inches, 8,000 lbs. per square inch. Stays above 1½ inches, 9,000 lbs. per square inch.	Not over 6,000 lbs. per square inch for iron stays. Not over 8,000 lbs. per square inch for steel stays.	$\frac{1}{5.75}$ of lowest test limit on net section. Then add ⅛ inch to diameter of stay.

are now used on a large scale, and it is preferable to have solid drawn tubes whenever possible. Stay-tubes are usually ¼ inch thick in the body, and these are used for stiffening the front and back tube plates. For this purpose they are screwed at each end with a fine thread (10 or 12 to the inch), and either tapped into both plates or tapped into the back plate, and screwed by nuts to the front plate. The better plan is the former, the back end thread is minus and the front end plus, and the tube screwed into both plates at the same time. The section of thread in this plan is in excess of that of the tube owing to its larger diameter, and the tube can be withdrawn at any time without disturbing the others, but if fitted with nuts there is great difficulty in getting the tube out, sometimes necessitating the withdrawal of a whole row. For 100 pounds working pressure and upwards, the stay-tubes being ¼ to ⅜ inch thick, every alternate tube should be a stay-tube; that is, in a nest of, say, 64 tubes there will be 16 stay-tubes.

As has been said the thickness of plates and pitch of stays are interdependent; the size and number of the stays depend on the pressure they have to withstand; the stays in the steam space must be so spaced that a man can pass between them, and for this purpose they should never be nearer than 14 inches center to center, but they are usually 15 to 17 inches centers, thus giving a clear space of 12 to 14 inches between them. These stays are seldom more than 3 inches effective diameter, but this varies to give a section adequate to the load each has to bear, and they are generally arranged in horizontal and vertical rows as nearly as possible, to admit of easy access. The stays are secured to the plates they are to support with a nut and large washer outside and a nut inside to lock, whose length is two-thirds that of the outside nut, which is one diameter long. The screwed stays are usually from 1⅛ to 1⅝ inches diameter with a fine thread. The most useful sizes are 1¼, 1⅜ and 1½ inches, suitable for 7/16 and ⅝-inch plates, and pressures from 60 to 200 pounds per square inch. When screwed through a plate whose thickness is less than half the diameter, there should always be a lock nut with a thin washer, the nut being two-thirds the diameter of the stay in length.

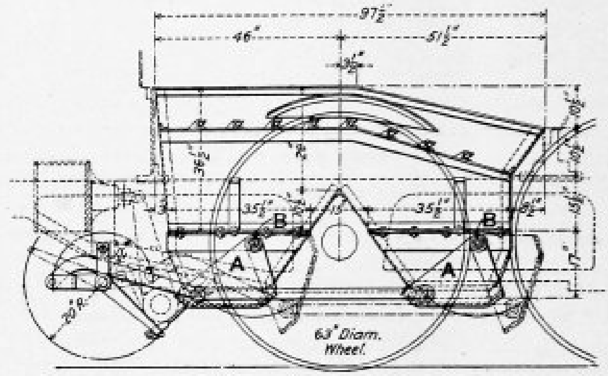
The water spaces between the furnaces themselves, between the furnaces and shell, and between the combustion chambers, although sometimes diminished, should not be less than 5 inches; that between the backs of the combustion chambers and shell should taper from 6 inches at the bottom to 9 and even 12 inches at the top to allow of the free current upwards of the steam generated on the surfaces. If the spaces are less than 6 inches it is very difficult to hold up rivets, to clean the surfaces from scale, or to get a good circulation. The space between the nests of tubes should not be less than 10 inches, and when possible should be 12 inches, as this permits a man to go down to clean across and ensures a good circulation.

The chief man-hole door in the shell should be oval, 16 inches by 12 inches, those in the ends may be 15 inches by 11 inches, and the smallest through which a boy can pass 14 inches by 10 inches. Mud-holes are generally 9 by 6 inches, and inspection holes 6 by 4 inches. The hole cut in the shell plating should be surrounded by a doubling plate to compensate for the metal cut away, and the holes through thin plates should have such rings to stiffen the edges. A better plan is to flange the plate inwards so as to stiffen the edge and give a good face for the door joints, this has now become general. The doors are usually placed inside the boilers, and held to their faces by studs screwed into them, which pass through strong cross-bars, or "dogs," held by square nuts.

Reference to the drawing on page 263 will make clear any points that may arise, and that have not been fully explained. This single-ended cylindrical boiler was constructed as one of the main boilers of a screw steamer, to supply steam at a working pressure of 180 pounds per square inch to a triple-expansion engine, having cylinders 20, 32 and 52 inches in diameter, respectively, with a stroke of 36 inches, cut-off 72 percent of stroke, indicated horsepower 1,500 at 90 revolutions per minute.

Wine Self-Dumping Ashpan.

The Atlantic Coast Line has adopted the Wine self-dumping ashpan as the standard on all of its locomotives, the changes to be made as rapidly as possible. The general feature of the design is shown in the accompanying drawing. The bottom of the hopper is closed by the slide *A*, which is pivoted or hung from the stud *B*. The mechanism by which it is moved to and fro consists of an ordinary arrangement of levers and connections which are operated from the side of the locomotive.



SELF-DUMPING ASHPAN.

It will be seen that the bottom is in the form of a pan that rises on all sides around the bottom of the hopper, and thus seals it against leakage. When opened it swings clear of the bottom, so that there is a free opening for the flow of the ashes.

The hoppers are separated from the main body of the pan and are held to it by key bolts, so that when it is necessary for a workman to go into the pan the keys can be easily knocked out and the hoppers dropped down.—*Railway Age Gazette.*

Naval Boiler Plant.

According to the *Army and Navy Register* the proposition which has been prevalent in some Congressional quarters for a year or more in favor of a government boiler-making plant for the navy appears to have been permanently shelved. It was never taken seriously by those who understood the situation, and probably it was never meant to be taken seriously with whatever purpose it was somewhat osentatiously expressed. It would take not less than $2,000,000 to build a plant before a boiler could be manufactured or to turn out such a type of boiler as the Babcock & Wilcox boilers. The government boiler plant is a bug-a-boo, which periodically presents itself, after the fashion of the armor-making plant, more as a cudgel to the existing sources of supply than for any benefit otherwise derived by the government. There may be another fight over the type of boilers to go into the new battleships authorized at the late session of Congress, but the bureau of steam engineering entertains no doubt as to its preference, and will again urgently recommend the Babcock & Wilcox type for both ships, in which case they are likely to be aided by the bidders who seek the contract for the one vessel to be built at a private yard. It is expected that on that occasion, as on previous competitions, the bidders will specify the Babcock & Wilcox boiler, despite its greater cost as compared with any other type, which circumstance is in itself an indorsement of the boiler. The battleship built at the New York navy yard will be designed for Babcock & Wilcox installation, for which a special contract will have to be made.

BOILER INSPECTIONS—THE OWNER, THE ENGINEER AND THE INSPECTOR.

BY G. M. DOUGLASS.

So much has been said upon this subject generally that it would seem there was very little more that we could say. There is, however, a condition in connection with boiler inspection that is not given the attention that seems to be necessary from what is known to prevail pretty generally throughout the country. This important point is the proper preparation of the boiler for the inspector. It seems strange that owners and operators of steam boilers should be so blind to their own interests as to neglect this important factor in the economical operation of their plants.

If your engineer was to come to you some day in your busy season and tell you that he would have to shut down your boiler on account of a bagged fire sheet, you would be considerably worried, particularly if you were well stocked with rush orders. This is likely to happen in any plant where the proper inspection and cleaning of the boiler is not given the attention it should have, as an accumulation of scale may settle on the fire sheets at any moment, causing the sheet to become overheated, with the consequent bagging and possible rupture. You may have a good engineer, but unless he is given time and opportunity to clean out his boilers and to have them inspected at periodical intervals, he does not know the internal condition of them any more than we do.

If steam users and boiler owners generally would give a little more attention to such matters, they would save during the year perhaps thousands of dollars. They insure their boilers, but they do not get, in many instances, the kind of inspection they should have, for the reason that the boilers are usually not properly prepared. Owners appear to think that they cannot afford the time to shut down for an internal inspection, and, as a consequence, the inspector has to do the best he can under the conditions, fully realizing that his inspection, if it could be called such, was anything but satisfactory.

When a boiler has been shut down with the idea of making an inspection it is often needed again within twelve or fourteen hours, and, as a matter of course, it is impossible between the shutting down and starting up again to either clean or inspect the boiler thoroughly. There is not time, for the reason that the boiler is too hot, as no boiler set in brickwork can be cooled down properly under twenty-four, and sometimes thirty-six, hours. It is not of much use to the owner or to the insurance company, either, to have an inspector go into a boiler that is so hot that he is obliged to come out for breath every few seconds; under such conditions he is unable to stay in the boiler long enough to give it the inspection necessary. Besides, the boiler should be thoroughly scaled and cleaned before the inspector goes in, to enable him to see what he is doing, as dangerous cracks and other defects may be hidden beneath a covering of scale.

Insurance inspections are made at periodical intervals, and the date the inspector is due is easily remembered if any interest is shown. When the inspector arranges for the internal inspection, the boiler should be shut down, the plates taken off as soon as possible after steam is off and the boiler allowed to cool thoroughly, after which the process of cleaning, scaling and washing out should be started, the grate-bars removed, the combustion chamber thoroughly cleaned and all soot brushed from fire surfaces with a wire brush—then, and only then, can the inspector do justice to the assured and his own company, and he will do it if he is given the opportunity.

Don't close up your boiler, either, if the inspector happens to be an hour late in arriving at your plant. He has other boilers to inspect, and maybe the boiler that he inspected at the last plant was so dirty that he has been obliged to secure extra clothing to enable him to keep his appointment with you, or he may have come by train and the train was late. We all know such things happen. The inspector carries along with him a bag containing tools, test gages and pump, overalls, and usually a change of clothing, which is a pretty good load for any one man to carry about.

This is mentioned particularly, as a very bad explosion might have been prevented on a certain occasion if the engineer had not been in such a hurry to close up his boiler. This inspection was arranged for a Sunday—at 11 A. M. The inspector arrived at the plant about 12 midday, as he had been delayed at another plant, and found the boiler closed up. The engineer being asked why he did not wait a little while longer, replied that he could not wait longer as he wanted to go home. The inspector, naturally, after hurrying to get to the plant in order to secure this boiler—which, by the way, was a new risk for the company insuring it—felt annoyed, but the best he could do with the engineer was to make an arrangement to inspect the boiler on the following Tuesday—two days later. On the day intervening, Monday, the boiler blew up, fortunately killing no one, but entirely demolishing the plant, with a property loss of over $23,000. From the condition of the plates which were examined after the explosion, it is certain that the inspector, had he gotten into the boiler on the Sunday, would have condemned it, as from previous reports it was understood that considerable corrosion was going on.

It will pay any concern well to shut down their boilers twice or thrice a year in order to permit the inspector to make a thorough internal inspection, as the opportunity given to clean off the scale, and clean the boiler otherwise, will amply repay in fuel saved, for the time taken, as the loss in heat transmission due to scale of the thickness of 1/16 of an inch will amount to as much as 10 or 12 percent, and we have record of more than one case where, after the boilers were thoroughly scaled and cleaned and settings altered slightly, a saving in coal of over 60 percent was shown.

The insurance inspector visits scores of steam plants yearly, finds all kinds of apparatus and conditions, has new experiences, and is up-to-date in matters pertaining to steam plant equipment, and is in a position to advise, and advise sensibly. Inspection work is not ideal by any means. The work is hot, dirty and disagreeable. The inspectors strive to perform, honestly, their duty in trying to detect weaknesses, defects and dangerous conditions if they are given the opportunity, and this is what they should be given. Make an effort to let the inspector have the boiler properly prepared for his inspection, and give him a reasonably cool and clean boiler to inspect. He will appreciate it, and the party insured will be getting not only his money's worth under his policy, but save hundreds of dollars annually besides. Boiler insurance without internal inspections properly made, we are sure is not what is wanted, but that is all that can be expected unless the inspector is given the opportunity to do his work.

A Record Repair Job.

We have received a communication from Mr. C. J. Elk, foreman boiler maker of the Washington shops of the Baltimore & Ohio Southwestern Railroad Company, stating that the capacity of the shops under his charge averages from thirteen to sixteen classes per month; one first and from one to two second class and the balance third and fourth class. This means one fire-box per month and an average of from 2,500 to 3,000 flues per month along with the other work which is necessary.

They also have 150 engines to care for. Fire-boxes run from six to twelve years and flues from ten to sixteen months.

Recently they had a radial stayed boiler come in unexpectedly for a complete new fire-box. On account of low water the crown, flue and door sheets were ruined, and it was considered more economical to renew the complete box, as the boiler itself and machinery was in first-class condition. It was suggested that the new box be applied as speedily as possible without interfering with the general run of work. The boiler was turned over to the boiler makers at 7 A. M, June 27, and was tested at 6 P. M., July 7. Mr. Elk states that they had none of the sheets flanged, so that all sheets were flanged by hand, laid out and fitted up in this time. The crown and side sheets were laid out, punched and fitted up in seven hours and ten minutes. This work was done under the supervision of Assistant Foreman E. Howard, and it is certainly a remarkable record.

FURNACE CRACKS AND THEIR REPAIR.

BY W. H. BOOTH.

One of the commonest forms of boiler trouble is the cracks which develop in the furnaces and combustion chambers. One never knows what a crack will do. Sometimes it will lie quiescent indefinitely; at other times it will extend steadily in length and will often leak freely.

The usual method of preventing a crack from extending is to drill a small hole in the plate beyond the limit of the crack but in line with it. The crack then extends forward and finally reaches the drilled hole, which will effectively stop further progress.

To mend a crack, a very common way is to rivet a patch over it. This, however, introduces the evil of double thickness with dirt between, and such patches are very apt to become burned. Another method is to cut out a large section of the plate adjacent to the crack and rivet a patch over the opening. This still leaves a double thickness at the overlap; but patches of this order are the only means available if there is tension on the plate.

Where a plate is not in tension it is sometimes quite allowable to use an entirely different scheme, a form of repair that has proved very successful. A hole is drilled about ⅜ inch in diameter just beyond one end of the crack and is tapped out with a fine thread. Into this tapped hole is screwed a plug and a second hole is drilled, partly in the plate and partly in the plug. This second hole is threaded and plugged, and the operation is continued until the whole of the crack has thus been drilled out and plugged. The plugs are then cut off flush with the surface of the plate and filed down smooth. Thus each plug is partly cut away and is keyed fast and prevented from turning by the adjacent plugs. Such repairs have been known to last indefinitely. But it must be borne in mind that only under compressive stress is this mode of repair practicable, for it has no holding together effect; the plugs merely serving to stop the crack and hold in steam.

Cracks often occur in the vertical parts of combustion chambers, or on the part of the furnace where it joins the combustion chamber. Doubtless these plates are sometimes badly strained in the bending processes and internal stresses are set up in them. Such plates are often better after being plugged than before they cracked, for they are no longer under such severe stress. Annealing is the process required to eliminate these stresses, but it is to be feared that such annealing is often neglected or is insufficiently performed, so that a fracture is often only a sign that the stress has been relieved.

In a homogeneous material such as mild steel, a crack once started will extend even beyond the area of the stress which caused it. Hence the need of drilling well beyond the point to which the crack can be traced. The crack will not pass the drilled hole if the stress has been relieved sufficiently by opening the worst part of the crack.

All repairs should be carefully carried out with discretion, and the method just mentioned was first brought to the writer's attention by a marine engineer of considerable experience who had successfully employed it for a number of years.

To repair a cracked furnace or other exposed part in tension by means of riveted patches is inevitable, but such patches are often very unsatisfactory, for they introduce the evil of double thickness, and almost invariably there is burning of the overlap. A patch put on without cutting away the plate beneath is even worse, for it forms a blister of a most severe nature.

It was the practice at one time to stiffen weak furnaces by riveting to them closely fitting hoops of iron, but almost invariably these would give trouble. The vertical portion was maintained comparatively cold by the circulation of the water, and the horizontal part was nearly as hot as the plate to which it was riveted. The expansion of this section caused great stress in the edges of the vertical web, invariably causing it to corrode. To remedy this evil the strengthening hoop was made of angle iron nearly 2 inches larger than the furnace to which it was fixed. This was firmly wedged into place and held to the furnace by tap bolts with nuts on the outside. By this method water is allowed to come in contact with all parts, there is considerable elasticity combined with the arched support of the hoop, and there is no differential expansion of the parts of the hoop to cause wasting as in the case of the closely attached hoop.—*Power and the Engineer.*

SPECIFICATIONS FOR STAYBOLT IRON.

At the recent convention of the American Society for Testing Materials, the Committee on Standard Specifications for Staybolt Iron submitted a revised specification, which under the rules goes over for one year. The changes consist of the following: The addition to the first sentence of the words "the basis of which must be pig metal and entirely free from any admixture of steel." The omission of the following matter: "The pile must be made up of a central core composed of bars from ½ inch to 1 inch square and be covered on all four sides with an envelope ⅝ inch thick. This pile must be rolled to a billet, allowed to cool, again heated, and then rolled into bars of the required dimensions." The substitution of a nick and break test for the threading test. The revised specification is as follows:

PROPOSED STANDARD SPECIFICATIONS FOR STAYBOLT IRON.

Process of Manufacture.

All staybolt iron must be hammered or rolled from a bloom or a box-pile having a cross-sectional area of at least 45 square inches, and not less than 18 inches long, the basis of which must be pig metal and entirely free from any admixture of steel.

Physical Tests.

(*a*) Tensile Strength.—Not less than 48,000 pounds per square inch.

(*b*) Elongation.—Not less than 28 percent in 8 inches.

(*c*) Reduction of Area.—Not less than 45 percent.

(*d*) Double Bending Test.—Close in both directions without flaw.

(*e*) Nick and Break Test.—A bar, nicked all around to a depth not less than 8 percent and not more than 16 percent of the diameter of the bar, and broken, shall show a clean fibre entirely free from crystallization.

(*f*) Vibration Test.—The test bar shall stand a minimum of 6,000 revolutions when subjected to the following vibratory test:

A threaded specimen, fixed at one end, has the other end moved in a circular path while stressed with a tensile load of 4,000 pounds. The circle described shall have a radius of 3-32 inch at a point 8 inches from the fixed end of the specimen.

INSPECTION.

(*a*) The Iron must be smoothly rolled and free from slivers, depressions, seams, crop ends and evidences of being burnt.

(*b*) It must be truly round within 0.01 inch and must not be more than 0.005 inch above or more than 0.01 inch below specified sizes.

Selection of Samples for Test.

The bars will be sorted into lots of 100 bars each and two bars will be selected at random from each pile. Failure of either of these bars to meet any of tne above specifications will be cause for rejection of the lot which the tests represent.

INDEXING SYSTEM FOR BOILER AND PLATE METAL SHOPS COVERING BLUE PRINTS, TRACINGS AND PATTERNS—III.

BY EDWIN E. ROHRER.

PATTERNS—OFFICE SYSTEM.

The system here outlined will be found closely interwoven with the system previously explained for indexing tracings, and this to the writer's mind is what makes the boiler end of it so practical, as it requires only a loose-leaf pattern number book in addition to what has already been purchased for the tracing system, and besides this all the data are collected altogether.

The system as here explained will be for both the boiler maker and the foundryman, as we believe most all boiler shops get practically all of their castings from one foundry. The first of this article will therefore be given up to an explanation of the system for the benefit of the boiler makers and a later part for the foundrymen. Each part, however, it must be understood, is closely related in one sense of the word.

A brief description of the style of pattern number book is the first thing to be taken up. The book we have found most satisfactory is a loose-leaf style, known to the trade as an 1-P Ring Binder No. 1801½. Now for this style binder we had special size ruled sheets made up. These sheets are 10¼ inches by 8½ inches, and should be ruled on one side only. The binding side of the above style binder is the 8½-inch side, and our reason for getting a special size sheet was so that same could be typewritten. The standard size sheet is 11 inches by 8½ inches, but this 11-inch dimension will not go into a standard size typewriter. We have the sheets ruled for twenty-five spaces horizontally, leaving ½ inch at the bottom and ¼ inch at the top. Each sheet also has five vertical red lines. The first line is spaced ¾ inches from the binding edge of the sheet and the next is ¾ inch, then comes a space of 5⅞ inches. After this line there are two more lines, ¾ inches apart. The space between the first two red lines from the binding edge is for the pattern number, then the description, then follows the order number and tracing number.

We have selected 100 as our first pattern number. This, however, is of little importance, but the pattern numbers must be arranged consecutively in the pattern number book, and, as previously stated, there will be twenty-five numbers on each sheet of the book. For example, patterns 100 to 124, inclusive, on first sheet, patterns 125 to 149, inclusive, on second sheet, and so on.

Each separate part of the pattern is to be given a separate number; that is, of course, each separate part that could be cast by itself and used in connection with another casting at any time. For instance, with a door and frame. The door is given one number and the frame another, for the reason that the door could be used on any frame of that size, while there would have to be a new frame made for a flat surface if the original was made to fit a shell radius.

Whenever a pattern number is required, the same is taken from the book and placed on the tracing and also on the card which is written up as an index to the tracing. The drawing number, it will be remembered, was placed on the upper right-hand corner of this card. Now the pattern number will be put on the upper left-hand corner when there is only one pattern number for the article. If, however, there are several pattern numbers for the same card, then we advise placing them along the left-hand margin. The pattern number should be placed on the card at the same time it is written up for the tracing.

We give below a fac-simile of a finished card for a clean-out door and frame:

```
            DOOR AND FRAME                 0-279
Patt.
1011    Frame 24" x 20" inside 25 1/4"
        x 28 3/4" outside to fit a flat
        surface.
Patt.
1012    Cover to have a lip down over
        frame, and to have 2- hinges to
        attach to frame.

                  #21903
```

SAMPLE INDEX CARD.

The system so far will enable you to find your pattern number on your tracing, or on your card, and if you are asked what pattern number 623 is you can turn to your pattern number book and there get the order number, drawing number, and a brief description of the pattern refered to.

The description of the pattern should always be written in the book at the time the number is used, then there can be no doubt as to what is the next blank pattern number. We advise writing this description in the book in lead pencil, and then when a page is filled have it typewritten for permanent record.

In the boiler or plate metal business we find it very necessary to have a system for filing and indexing patterns that will allow of many changes in the original patterns, for the reason that the boiler maker's patterns are used on so many different diameter shells and dished heads, and are often located off center, so say nothing of the special work he is often doing. The boiler maker must, therefore, be able to use his available patterns to the best advantage and with the least possible expense for alterations, and should be able to know at the time he is quoting his price just what patterns he will use or just how he will alter them. It is the purpose of this system to simplify the above conditions so that the boiler maker may know about what is being done with his patterns at the foundry, and with this thought in mind we will proceed to show how one can take care of the altered patterns.

Taking a practical example to illustrate how this part of the system may be cared for, we will consider a 16-inch diameter nozzle pattern, 8 inches high, to fit a flat surface, and give it pattern No. 476. Now suppose you require a nozzle of same size to fit a 48-inch shell radius. You at once see that all you require is a new rivet flange or shell flange, and same is to be given pattern No. 476-A. If, at a later time, you require the same nozzle to fit a 24-inch radius you give the new rivet flange pattern No. 476-B. Now if the nozzle is to have the bolt flange a little larger in diameter, and same can be changed by attaching a light strip around the outer edge, you will not require any pattern number for this. In other words, the pattern as originally made is given a number only. Any new part that is made to alter the pattern is given the original pattern number with a letter after it. If, however, the pattern is lagged up or altered in a temporary way there is no pattern number used, for the reason that such alterations are not permanent. The essential requirement of this part of the system is to have some idea how the patterns are being made, so as to be able to tell just what changes can be made to an advantage. Bear in mind that no pattern should be changed unless it can be changed back to the original.

Referring again to the pattern number book it should be noted that these pattern numbers with letters after them are not recorded in this book, for the reason that these numbers are kept consecutive. The pattern number is placed on the tracing and also on the card. Now the important thing to do is to file these cards in order so that the card with pattern 476 is in front and right next to it card 476-A, then 476-B. In doing this you can always tell what the next letter is for any pattern number. If asked what 476-A is you can refer to your pattern book for the original 476, then turn to your card index find 476, and next to it you find 476-A.

The final article of this series will appear in a later issue under the heading of "Patterns—Foundry System," and will describe the system of storing the actual patterns.

USE AND CARE OF PNEUMATIC TOOLS.*

The question which we are to consider is one of the most vital entering into the most successful and economical use of compressed air tools in railroad shops and elsewhere—a question upon which largely depends the getting of the very best results out of pneumatic tools, namely, the care and maintenance of pneumatic tools. It is doubtful if any piece of machinery pays a greater profit on its investment or cost than a pneumatic hammer or a pneumatic drill kept in good working condition, yet I am sorry to say it is equally doubtful if there is any piece of high-speed machinery so much abused by neglect to properly clean, oil and renew worn parts, which condition retards the full admission of air to all parts, interfering with the free movement, and rapidly cuts down the efficiency and capacity of the tools. Pneumatic tools, like all other high-class machinery, must receive proper care and lubrication to give the best results. One of the most important factors connected with their proper care is to keep them clean and well lubricated. All pneumatic tool companies should proportion and construct their pneumatic tools in such a way that none of the parts will break from actual service, unless some part is defective and escapes the different inspectors' notice at the factory, which is liable to happen once in a great while in the most up-to-date and best regulated plant in the world; but if a wood boring drill, or a metal drill, is improperly applied, that is, used on other work than for which it was designed and built, or overloaded by forcing them beyond their rated capacity, something may happen. For instance, if a drill is constructed to drill 1¼-inch holes and is used for drilling 2-inch or 2½-inch holes, then something may happen.

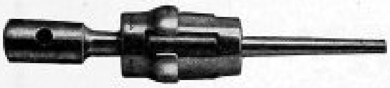
It is reasonable, however, to expect, and it is a fact, that in pneumatic tools, as in all other high-speed machines, the rapidly-moving parts will wear in time—the pistons, ball races, balls, throttle valves, etc., in pneumatic drills, and the throttle levers, bushings, valves, pistons and cylinders on pneumatic hammers, and when the wear is sufficient to prevent the full and free admission of air, or the escape of air by leakage past a worn part, it reduces the efficiency of the tools, and the part, or parts, should be removed. If this is done the machines will maintain their efficiency indefinitely.

The greatest abuse, therefore, to which pneumatic tools can be subjected is the failure to properly clean and lubricate them, and almost universal feeling seems to predominate on the part of operators that a pneumatic tool should run and develop its full power so long as all the parts are held together, without any regard to cleaning, oiling or tightening up. How long would a man last if you didn't give him water or food to sustain him? Not long, I am sure. The cleaning and oiling of pneumatic tools should not be delayed until they stop working on account of dirt, rust or gummed oil. They should be thoroughly cleaned with kerosene or benzine once every twenty-four hours, as the air taken into the compressor generally contains some grit or dust. It is almost impossible to prevent this foreign matter entering the working parts of the tool, thus causing the parts to become clogged and rendering the tool inoperative. A good plan in such cases is to thoroughly clean by pouring benzine or kerosene freely into the throttle handle. This dislodges all foreign matter and cuts the thick oil, which can be removed by blowing the air under pressure through the tool, then lubricate in like manner with a good quality of light body oil. Sewing machine oil or a winter strained lard oil is very good. Heavy oils should never be used on pneumatic hammers or piston drills, as they cause the tool to work very sluggishly, with consequent loss of power. However, heavier oils should be used on the rotary type of drills.

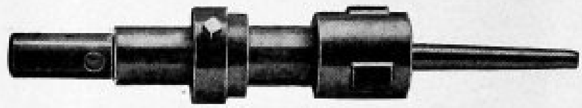
When pneumatic tools are not in use it is a very good plan to keep them immersed in kerosene. They should be suspended so that the dirt and foreign matter will settle to the bottom of the vessel and then thoroughly blown out and well lubricated before being put into operation, as kerosene leaves them dry. It will well repay a user of pneumatic tools to keep the inside of pneumatic tools as clean and well oiled as a sportsman would his gun. We advocate, especially where the air is usually laden with foreign matter, the use of strainers on the tool and filters in the pipe line, arranged so that they can be readily taken apart and cleaned. A good form of pipe line filter is two cast flanged pieces properly tapped and threaded to fit the pipe line, bolted together, with a piece of gauze or fine mesh wire screen between. This can be made in any railroad shop. There are also sundry makes of automatic oilers for pneumatic tools, which are placed in the hose line a short distance from the tool, and which can be refilled at any time without disconnecting the tool from the hose line. They are made in sizes to supply oil for from six to eight hours without refilling. We recommend their use.

Another abuse, especially with regard to pneumatic riveting hammers, is a rapidly-increasing tendency on the part of operators, particularly where the hammers are used in construction of steel cars and in structural steel shops, more especially where "hunky" labor is employed, to use pistons shorter than those adopted by the makers as standard. This is the most flagrant abuse to which a riveting hammer can be subjected, and I cannot too strongly condemn this practice. The riveting hammers are designed with parts properly proportioned to meet the requirements of the various classes of work to which these tools are adapted. Workmen have discovered that a shorter piston than the one furnished with the hammer increases the number of blows per minute and for a time facilitates their work. They usually make these pistons by grinding down a broken standard piston, thus removing the hardening in a large degree, and leaving the striking part softer than it should be. These short pistons have a tendency to crumble and the broken parts cut the inner casing of the cylinder, and if it is not damaged beyond repair from this core it is only a question of a short time when the cylinder will crack or the handle will be broken. When cracked cylinders, broken handles and broken rivet sets are experienced the hammer should be carefully examined to ascertain whether or not the workman has substituted a short piston, and this can only be done when the hammer is in service, as it has been found that the workmen carry the short pistons with them and make the exchange after taking the hammer out of the

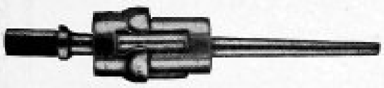
* Address of J. H. Simmons (representing the Ingersoll-Rand Company) before the Railway Tool Foremen's Association.



"Boss" Roller Expander (Hand Use)



Arch Flue Expander



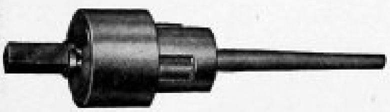
"Boss" Roller Expander (Self-Feeder)

FAESSLER

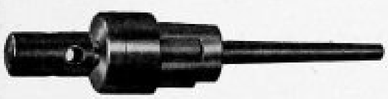
BOILER MAKERS' TOOLS

ARE STEEL THROUGHOUT

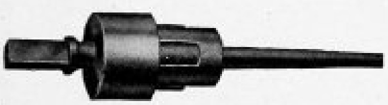
Universal Expander (Hand Use)



Universal Expander (Self-Feeder)



Removable Collar Expander (Hand Use)



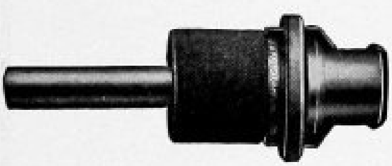
Removable Collar Expander (Self-Feeder)

This strong point is but one of many that skilled boiler makers invariably recognize in Faessler Tools.

Space here does not permit describing each in detail. If it did, we think we could easily convince you beforehand of the ability of any Faessler tool to withstand the hardest knocks of severe service and do first-class work under trying conditions.

But better than this, we want you to see for yourself in your own shop that our claims are not exaggerated. Tell us the size and kind of tools needed, and we will supply your wants on condition that our tools must prove highly satisfactory in every way or may be returned at the end of a 30-days' trial.

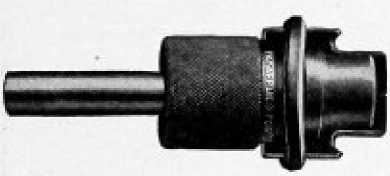
TRADE MARK BOSS REGISTERED



Rapid Beading Expander

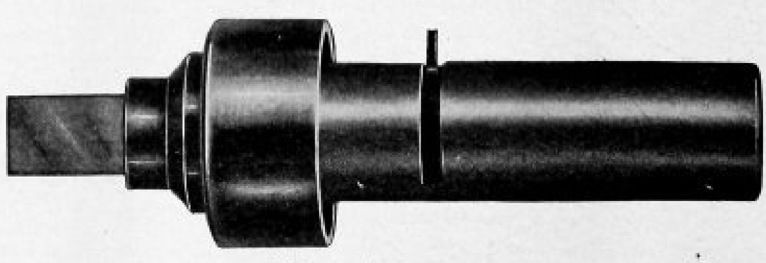
J. FAESSLER MFG. CO.

MOBERLY, MO.



Rapid Beader Tool

Improved Sectional Expander



"Perfect" Flue Cutter

tool room, replacing the proper piston when returning the hammer at the close of the day. In some of the large manufacturing plants hammers have been discovered working with a short stub of a piston not more than 2 inches in length, ground conical on the striking end, and the managers of these plants have issued instructions making it an offense punishable by discharge where such conditions are found. One of our largest industrial organizations, operating some eight or ten plants, inaugurated about a year ago a system for keeping a thorough inspection and record of pneumatic tools from the day of purchase until they had become obsolete or worn out. A record is kept of every item of repair made to a tool and a report filed showing why the repairs are made necessary; that is, whether from abuse, lack of care, bad hose, natural wear and tear, or accident. The mechanical engineer in charge of this recently informed me that in looking over the report for the first six months he was greatly surprised to find that about 30 percent of the cause of repairs could be directly attributed to neglect in cleaning and oiling and about 15 percent to the use of inferior hose.

Another important factor to be considered in the getting of the very best results out of pneumatic tools is the air pressure; and speaking of air pressure recalls to my mind an experience I had some time ago. Passing by a large manufacturing plant I noticed a workman at a nearby open window using a pneumatic hammer which sounded very weak. Upon approaching him I asked him if they did not have high-air pressure at this plant. He replied to me this way: "Ah, sure, an' they hav, man. Phoy they hav it up as hoigh as the fifth floor." After further investigation I found they had sometimes 60, more often 50 pounds, of air pressure. Now, gentlemen, while, as my friend said, they had the pressure up as high as the fifth floor of this plant, 50 or 60 pounds cannot be considered as high pressure for pneumatic tools. We have found after a very careful and painstaking investigation that inasmuch as the air pressure is concerned, one should have between 90 and 100 pounds of air to get the very best results out of pneumatic tools. For instance, the Canadian government will not accept steam-tight rivets driven with pneumatic hammers unless these hammers are operated by 110 pounds air pressure. All pneumatic tools can be operated on less pressure, but you will find, as I say, that 90 to 100 pounds of pressure will give the best results.

In conclusion allow me to offer a few suggestions applying to all makes of pneumatic tools which, if followed, will insure you more and better work from your equipment and will obviate delays and annoyances and minimize the expense of maintenance:

First see that the tools are well cleaned and boiled before putting them in operation.

See that the pipe lines are thoroughly blown out before connecting the tool.

Use the best quality of air hose. It is cheaper and more satisfactory in the long run.

See that your pipe lines are provided with filters or that strainers are used with the tools, preferably both.

With drills, adjust the ball bearings where they are provided so as to take up the lost motion, and be sure that they are firmly held by the lock nuts to prevent working loose or tightening up and binding when in use.

With your pneumatic hammers be sure that the handle is always on tight, as the tools may be seriously injured by allowing this to work loose. This controls the joint between the handle and valve box, and is of great importance.

See that the operators hold their riveting and chipping hammers firmly against the work. If the die or chisel is allowed to play in and out of the hammer while in operation it will seriously damage the tool. Every blow should be delivered on the die or chisel, and not on the forward end of the bridge of the cylinder in chipping hammers. With riveting hammers, which have no bridge in the cylinder, it often means the loss of the die and piston by being shot out of the tool. Besides, in structural work it makes it dangerous to pedestrians in street and thoroughfare below. There is no way of protecting against injuries of this nature except by care on the part of the operator.

See that the chisel and rivet sets fit properly in the nozzles and are of proper length, otherwise there is an opportunity for loss of power and injury to the tool.

The Board of Trade Report on Boiler Explosions.

With their not unusual tardy procedure in such matters the British Board of Trade authorities have only just issued their annual report for the year ending June 30, 1909, on the working of the Boiler Explosions Acts of 1882 and 1890. In conformity with the provisions of these acts, eighty-five "preliminary inquiries" and eight "formal investigations" were held in connection with boiler explosions during the year covered by the present report. There were thus ninety-three explosions investigated; arising therefrom twelve people lost their lives and fifty-three were injured.

In the manner of all official reports, we find these figures compared with the averages for previous years, the differences noted, summaries given, and a few brief remarks made on other statistical features revealed in the course of the investigations. Thereafter we are left to draw our own lessons and conclusions, unaided by the official hand in all but minor aspects. Collectively the summaries are capable of yielding broad yet valuable generalities quite distinct from the detailed information to be obtained from the full reports published separately for each case. Yet the official summary neglects this opportunity, contenting itself with an annual expression of satisfaction or the reverse, according as the averages fall or rise. This year the report expresses satisfaction. Since the passing of the act in 1882 the average number of explosions per year has been 69.3, the average number of lives lost 27.1, and of persons injured 57.9. It will thus be seen that although the total number of explosions is higher than usual, the number of fatal accidents shows a marked decrease, while the injuries have also been less. Hence the official satisfaction. But to those more directly associated with the manufacture and working of steam boilers the figures of the report cannot, we think, bring the same amount of pleasure. From a purely humanitarian point of view, we may doubtless rejoice that the multifarious uses to which steam is now put have involved no greater loss in the past year than that indicated above. Looked at from the mechanical standpoint, too, the figures may be found to show an apparent improvement. In the year 1884-85, for example, there were forty-three explosions and forty lives lost, or, say, one life per explosion. This year we may take it at one life in every eight accidents. But both the humanitarian and the mechanical aspects are incomplete. Neither takes account of chance, nor can any official report or system of analysis reveal to us the extent to which the risk of boiler explosions has been decreased during the past twenty-seven years. That the number of lives lost is not in the least a safe index must be obvious. Neither is the ratio of lives lost to number of explosions. If it could be determined the ratio of the number of explosions to the number of boilers in existence might afford us some guide. But although the Board of Trade returns yield us the numerator of this ratio, we are in entire ignorance as to its denominator. Yet it is this aspect, the reduction of risk, that is the most vital of all—the only one, in fact, whereby we may truly judge the advance being made and the advantages of insurance, inspection and inquiry. Forty-five of the ninety-three accidents reported in the present summary involved loss of life or personal injury. But that the remaining forty-eight resulted in no serious injury must not be taken as a sign of better times and better methods. It is due merely to the operation of the law of chance.

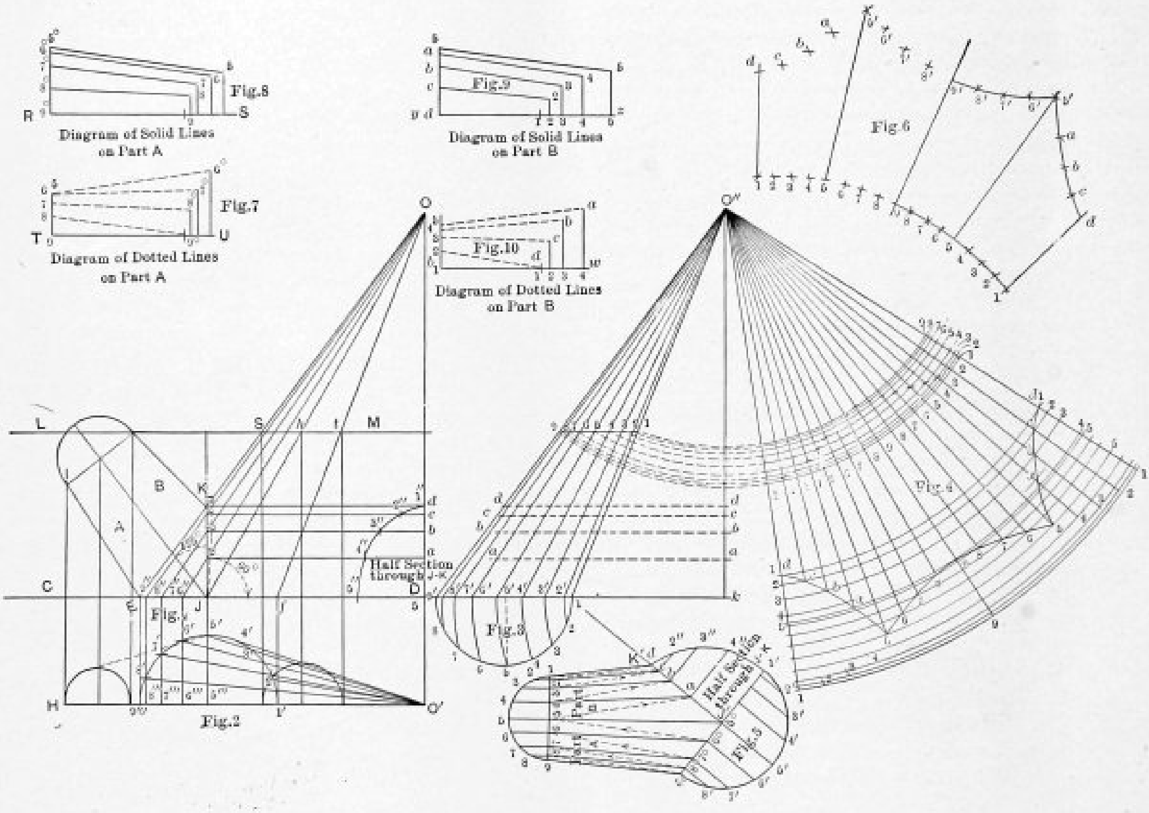
It is impossible here to analyze fully the information set forth in the report. We can only touch upon one or two of the more outstanding features. Of the causes operating to produce explosions, deterioration or corrosion is easily the most fruitful, thirty-six cases of this sort being tabulated. Water hammer accounts for nine, and defective workmanship, material or construction for twelve. Faulty design or undue pressure was responsible for thirteen of the accidents, ignorance or neglect of the attendants being attributed in fifteen cases. The influence of inspection on the reduction of disaster to boilers—as distinct from their adjuncts and accessories—is exhibited in the report, where it is stated that in thirty-seven cases the boilers were under the inspection of public bodies, while in twenty cases there was no inspection by a competent person for several years before the date of the occurrence. The report adds that of the thirty-seven cases in which the exploded boiler was under inspection, thirteen were due to causes other than defects in the material. As usual, antiquated boilers, bought cheaply and used ignorantly, figure largely in the list. The failures of steam ovens and steam-heating apparatus are also serious and, if we may believe the report, show all too frequently careless handling as the direct cause. Thus, it is stated, seven steam heaters exploded because the fires were lit when the circulating pipes were choked with ice, thus causing excessive pressure within the boiler. It is curious to note that in his report on the eight "formal investigations" the solicitor to the Board of Trade states that "the causes of these explosions have been clearly ascertained, and in no case has the explosion been attributable to unavoidable accident." Both parts of this remark are indicative of that finality of judgment invariably expressed in official documents. "Unsolvable problems" do not exist in the official world, and as a cause has to be found for every accident, that cause *must* be neglect or carelessness on the part of the boiler attendant, the makers, the works manager, or the insurance company's inspector.—*The Engineer.*

LAYOUT OF A BRANCH PIPE.

BY JOHN COOK.

A piece of sheet metal work that is often built for hydraulic work is the branch pipe shown in the illustration, the branches of which are of different degree angles and different size openings. Figs. 1 and 2 show the elevation and half plan for a branch pipe of the above description, one branch of 60 degrees and one of 125 degrees.

The 60-degree branch can be developed as a scalene cone. Draw the base line *C-D*, also the line *L-M*, the height required.



DIAGRAMS AND PATTERNS USED FOR LAYING OUT A BRANCH PIPE.

Erect the perpendicular line *J-K*, and lay off each side of *J-K* the half diameter of the main pipe *E-f* on line *C-D*, and drop lines from *E-f* and *J-K*, so that half the plan can be drawn. On line *H-O'*, drawn parallel to *C-D*, lay off the angle required from line *C-D*, and draw the line *J-h* indefinitely; then mark on *L-M* each side of *J-h* half the diameter of opening as at *s-t*, then draw the lines *E-s* and *f-t*, extended to cut the line *J-h* at *O*.

Draw the half circle, Fig. 2, and divide it into any number of equal parts as shown in this case eight equal parts are used. Erect lines from the points 6, 7, 8 and 9, cutting the line *C-D*, as shown by 6'', 7'', 8'', 9'', and from these points, with straight edge resting on the point *O*, draw lines to the point *O*. Where these lines cut the line *J-K* will be the point of intersection. Drop line from *O* on elevation to *O'* on plan, and draw horizontal lines from points on line *J-K* and parallel to *C-D*, cutting the line *O-O'*; then take the distance 8''' to 8', and mark as shown from *c* to 2'', the same from 7''' to 7', and mark from *b* to 3'' and from 6''' to 6', and mark from *a* to 4'', and from 5‴ to 5; draw curved lines connecting those points, and the half section through *J-K* will be completed.

We will now consider the part which is to be treated as a scalene cone. Draw the line 9′*k*, Fig. 3, set the trams from the point 5‴ to *O*′ on line *H-O*′, Fig. 2, and with *k* as a center scribe a point on line 9′ *k*, as at 5, and draw the half circle and divide it into the same number of equal parts as the half circle in Fig. 2. Using *k* as a center set the trams to the points on the half circle and scribe points on line 9′*k*. Erect the vertical line *k-O*″ the same heights as *D-O*, Fig. 1; draw lines from points 1′, 2′, 3′, 4′, 5′, etc., to points *O*″ mark off the points *a*, *b*, *c*, *d* on line *k-O*″, and draw horizontal lines, cutting the radial lines as shown.

To get the development, set the trams from point *O*′ to points on line 9′*k*, Fig. 3, and draw arcs as shown on Fig. 4; then with the dividers set to spaces on the large half circle at the bottom of Fig. 3, step off from one arc line to the other on the bottom. For the top part all that is necessary is to cut the radial lines with the trams; set to the different points on Fig. 3 to get the cut-out on a section through *J-K*, Fig. 1. Set the dividers from 5″ to 4″ on the curved line, and carry to Fig. 4 and mark from 5 to *a*. Set the dividers from 4″ to 3″, Fig. 1, and carry to Fig. 4, and mark from *a* to *b*. Do the same with the rest, taking the distance from 3″ to 2″ and 2″ to *d* on Fig. 1, and carry to Fig. 4, etc. Connect these points.

As the points just located represent centers of holes and will be right on the crotch, it would be better to raise *b*, *c* and *d* a little. It all depends on the thickness of metal, however, and if preferred one part of the leg can be cut to this line and enough allowed on the other leg for the flange, as shown by dotted lines, Fig. 1.

Fig. 5 is a duplicate of *A-B*, Fig. 1, and shows plan for getting development by triangulation. Figs. 7 and 8 are diagrams of true lengths of lines for part *A*. Figs. 9 and 10 are for part *B*, as explained on diagrams.

For the development draw a vertical line on a convenient part of the sheet, and lay off on it the distance from 9° to 9 on diagram of solid lines, Fig. 8. Then with trams set from 9° to 8, Fig. 7, carry the distance to Fig. 6, and with one point resting on 9′ scribe arcs each side of 9. With dividers set to the spaces on the small semi-circle, and using 9 as a center, scribe arcs, cutting the arcs made with the trams and establish the points 8 on each side of the center line 9′-9. With the trams set from 8° to 8, Fig. 8, scribe arcs as shown on each side of 9′, and with the dividers set to spaces on the large half circle strike arcs cutting the arcs last made, as shown at 8′ 8. Then with trams set from 8° 7 on dotted lines, Fig. 7, and using 8′ and 8 as centers, scribe arcs as shown at 7-7, Fig. 6. With the trams set from 7° to 7, Fig. 8, and using 7° as a center, with dividers set to spaces on the large half circle, scribe arcs cutting the arcs made with the trams, and do the same with points 5 and 6, and it will complete part A. Part B is a little different, as shown by the way the arrows point; also the procedure is different in getting the points *a*, *b*, *c*, *d*. The spaces on the curved line, Fig. 5, are used instead of spaces on the half circle.

Set the trams from 5 to *a*, Fig. 10, and carry the distance to Fig. 6; with one point resting on 5 strike an arc as shown, then with the dividers set from 1′ to 2″ on the curved line, mark the half section through *J-K*, Fig. 5. Carry to Fig. 6, and from 5′ as a center scribe the point *a*, then set the trams from 4 to *a*, Fig. 9; and with *a* as a center, Fig. 6, strike an arc outside of the points 5-5, and with the dividers set to the spaces on the small circle cut these arcs and establish the points 4-4. Do the same with the rest on parts B, using the spaces on the curved line marked 2″ to 3″, 3″ to 4″ and 4″ to *d*. Lines can be drawn as shown from 9′ to 9 and 5′ to 5, and the end lines for line of holes. The lap must be allowed on the end lines 1 to *d*.

TO LAYOUT HOLES UNEQUALLY SPACED.

BY FRANK T. SAXE.

It has invariably been the practice in boiler shops when holes were laid out unequally spaced in a cylinder, and there was to be another course or band go on the same, to roll the course up blank and mark it from the cylinder with the holes. As this involves a great amount of labor, the methods shown in Figs. 1 and 2 are used by the writer whenever he is confronted with such a problem.

In Fig. 1, on the line *AB*, is the layout of the holes of a 24-inch cylinder, built of ¼-inch material. Now we will assume there is to be another layout of a cylinder of the same material to go on the outside. As the rule is to allow six times the thickness of the material for the difference in the layout, we add on six times ¼ inch or 1½ inches from *B* to

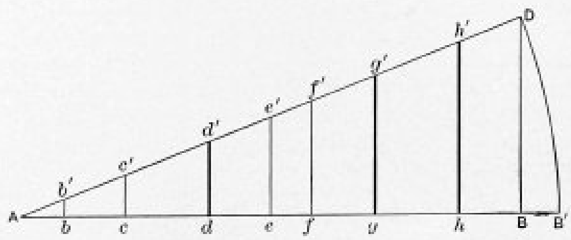


FIG. 1.

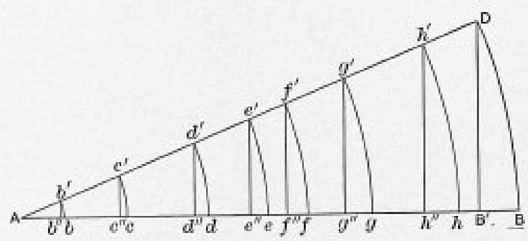


FIG. 2.

B′. Then with *A* as a center and a radius to *B*′, we describe an arc of an indefinite length. We now erect a perpendicular at *B* intersecting the arc at *D*. From the point *D* draw a line to *A*, which forms the hypotenuse of the triangle *ABD*. By drawing lines parallel to *BD* from the points *Abc*, etc., to the hypotenuse, we have the layout of the holes for the cylinder going on the outside. This method applies to the course going on the outside.

Assume now we want the course to go on the inside. Fig. 2 is the layout of the same cylinder. From *B* to *B*′, instead of adding on the six times we deduct six times ¼ inch, or 1½ inches from *B* to *B*′. Then with *A* as a center, and a radius to *B*, we describe an arc of indefinite length. Now erect a perpendicular at *B*′ intersecting the arc at *D*. Draw the line *AD* with the same center and radius to the points *A*, *b*, *c*, etc. Describe arcs intersecting the line *AD* at the points *b*′, *c*′, etc., then draw lines parallel to *BD* from the points *b*′, *c*′ back to the line *AB*. We now have the layout for a course going inside at the points *A*, *b*″, *c*″, etc.

I have used these methods on several jobs where it was impossible to space the holes in equal on account of castings and lifting lugs going on a tank, and the holes have the appearance of being drilled through both plates when assembled.

A Study in Heat Transmission, by J. K. Clement and C. M. Garland, is issued as Bulletin No. 40 of the University of Illinois Engineering Experiment Station. The bulletin describes a method of studying the effect of the agitation of a medium in contact with metal walls upon the heat conducted through these walls, and to or from the medium. Results of experiments upon the heat transmitted to water, as the medium in contact with the walls of the tube, under varying velocities or rates of agitation, are given. The experiments were made upon a 1-inch steel tube, through which water flowed at different velocities; a record of the amount of heat transmitted was obtained from the weight of water and the rise in temperature passing through the tube. The "conductance," or the reciprocal of the resistance of the metal of the tube and of the film of water on the water-side of the tube, and of the film of water on the steam-side of the tube, was obtained by measuring the temperature of the surface of the tube in contact with the steam with small thermo-couples, and computing from their temperature the drop in temperature through the tube and through the film. The results show that the resistance of the film on either surface is greater than the resistance of the metal of the tube, and also that increases in the velocity of the water, or the rate of agitation, reduce the resistance of the film on the water-side, and consequently increase the amount of heat transmitted from steam to water. Copies of Bulletin No. 40 may be obtained gratis upon application to Mr. W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

CONSTRUCTION OF A 90° ELBOW RUNNING FROM A ROUND INTO A RECTANGULAR SECTION.

BY C. B. LINSTROM.

This particular problem requires a separate development of each section in order to obtain the respective patterns. All of the sections with the exception of the two outer ones are irregular and in the form of transition pieces. The two outer sections, A and F, are different in form according to their respective profiles, as shown in the elevation. The parallel system of development is the method suitable for their construction. Triangulation is the method used for the development of the remaining sections.

Owing to the irregularity in shape of the different sections, a great amount of time and labor must be expended to secure the correct patterns. As a rule, in order to overcome these complicated conditions it is the practice to construct a transition piece at the irregular end, the shape of which in this case would be from a round to a rectangular section. A regular 90-degree round elbow can then be used, which will answer the purpose as well and obviate the necessity of making so many different layouts. However, to demonstrate the principles involved in constructing this problem, a drawing and an explanation of same is given, which may be of some interest.

It should be borne in mind, when designing work of this character, that the important feature consists of providing ample air space for the conveyance of the gases. It is a well-known rule that governs both liquids and gases that the discharge through any line of pipe is governed according to its area.

Owing to the flat sides running into a round section a change of profile in each section will result. To obtain these different profiles means must be provided to show to what extent these changes in form are in evidence in the different sections. Referring to Fig. 1, it will be understood from the drawing that there are in each section subjected to this change in shape four flat sides, one of which is on the outer curve of the elbow, one on the inner curve and the other two along the outer sides. The length and width of these flat sections will, of course, depend upon the number of sections in the elbow and the size of the profiles. The curved portion connecting the flat section will naturally be elliptical in shape. The question as to how many sections will compose the elbow is a matter to be decided by the designer. In this instance the problem is made up of six sections.

CONSTRUCTION.

As the principal dimensions of the elbow are shown in the elevation and profiles, these views should be drawn first. The preliminary drawing of the elevation is done in the usual way as for an ordinary round 90-degree elbow. The outside and inside arcs are drawn to their required radii, using point W as a center. Divide either arc into the required number of divisions, in this case six. From these points lines are drawn through the elbow to the apex W, which locates in the elevation the miter lines between the sections.

Section E of this problem is developed, and the explanation relating thereto will be sufficient to make clear the requirements involved for laying out the remaining sections. Before the plan view of this section can be constructed some preliminary drawing must be done to secure the proper profile through the plane c c', Fig. 1. These auxiliary views are shown at Figs. 4, 5 and 6. Fig. 4 is a view showing the respective heights of the sections on the center line P V; that is, the length of the lines P P', Q Q', R R', etc., shows the relative distances of the flat surfaces from the center line of the profile. This view is constructed as follows:

A horizontal line is drawn indefinite in length, and upon it are set off the distances P, Q, R, S, T, U and V, taken from the center line of the elevation. Perpendiculars are then drawn from these points. From P and Q set off a distance equal to the radius of the circle. From U V set off the distance equal to H i of the rectangle. Connect Q' U' as shown, thus determining the required heights for the profiles.

The next operation will be to show in the elevation to what extent the flat side H K is in evidence in each section. This is done by dividing u f and u f' into the same number of divisions as there are sections subjected to the change in shape; in this case four. Set off on either side of T the distances T 4 and T 4' equal to the distances u 4 and u 4', respectively. Connect 4 4' to f and f', as shown.

In a like manner continue the operation for the remaining sections, using the distances u 3 and u 2, respectively. As stated previously, the flat sides are also on the outer and inner curve, running from the length of the side H j of the rectangular profile to nothing at the intersection between sections F and E. The view showing the construction on the outer curve a g is shown in Fig. 6, and Fig. 5 represents the shape of flat surface on the inner curve a' g'.

To accomplish the results as shown in Figs. 5 and 6 proceed as follows:

Draw stretch-out lines, as a' g', Fig. 5, and a g, Fig. 6. On line a' g' set off the distances a' b', b' c', etc., which are taken from the inner curve. Erect perpendiculars, as shown, through the points g', f', e', etc. A distance equal to H i of the rectangular profile is then set off from f' and g'. Connect line f' with point b', which completes the figure and shows the shape of the flat surface. The same construction is applicable to Fig. 6. It is, of course, necessary to use the spaces on the outer curve a g in order to secure the correct view.

CONSTRUCTION OF SECTION E.

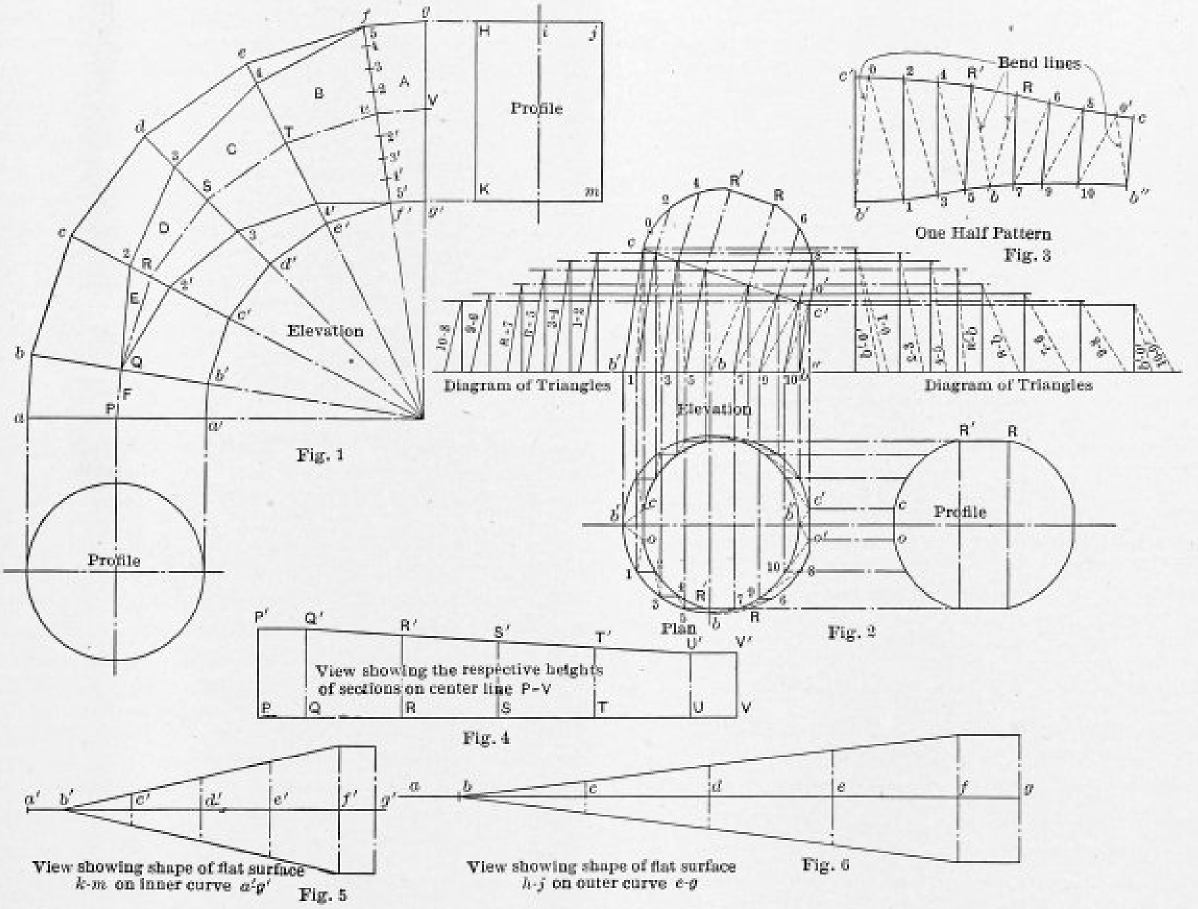
Since the different sections require a separate construction for their proper development a detail explanation therefore will be given for the layout of section E. The principles as explained are applicable to the remaining sections. Fig. 2 gives the complete construction of this section.

The first requirement essential in this construction is to erect an elevation corresponding exactly in form to the view as shown in the elevation, Fig. 1. A correct profile must then be drawn, showing the shape of the connection through the plane c c′ of the elevation. Since the connecting plane between sections F and E is a true circle, the plan view of this portion will be represented by a circle, which is drawn with a radius equal to b b′ of the elevation, Fig. 2. Proceeding further with the construction of the plan view it will be understood that the plane through c c′ of the elevation will be shown foreshortened in the plan, owing to the angle the plane makes with the horizontal plane of projection. To obtain this result a true profile of the plane must be drawn to the right of the plan view and also at right angles to the elevation as shown. The construction of the profile is as follows:

At right angles to the horizontal axis of the profile erect the perpendiculars R′ R equal in length to the distance R R′

The construction of this problem so far is complete, the remaining work necessary is to secure the pattern; in order to do so the first requirement is to find the true length of the solid and dotted construction lines shown in the plan view, Fig. 2. The drawing in the production of these lines is shown to the right and left of the elevation, and is termed the "Diagram of Triangles."

The reproduction of these triangles in the pattern is a simple matter. A study of the pattern will show how the operation of transferring the triangles was done. The stretch-out spaces for the connection to section F are taken from the true circle plan view, and those for the irregular connection from the profile shown to the right of the plan.



DIAGRAMS AND PATTERNS FOR THE LAYOUT OF AN IRREGULAR 90° ELBOW.

of Fig. 4. The width of the flat section is equal to the distance 2 2′ of the elevation, Fig. 1. The flat portion c o of the profile is equal to the distance c of Fig. 6, and the opposite flat section is equal to the distance c′ of Fig. 5. Join the flat sides with elliptical curves. One-half of this same profile is drawn above the elevation.

The foreshortened view of the plan will now be obtained and in the usual way. Divide the curves of the profiles into the same number of equal spaces; project these points of division as shown to the plan view; through the point of intersection between the projectors draw the required curve and the relative flat portions which complete the view. Divide the true circle plan view into the same number of divisions as there are in the profile. On the circle they are numbered as follows: b′ 1, 1 3, 3 5, 5 b, b 7, 7 9, 9 10 and 10 b″. On the irregular view they are o 2, 2 4, 4 R′, etc. Alternate dotted and solid construction lines are then drawn, as shown in both plan and elevation, Fig. 2.

American Society of Engineer Draftsmen.

An organization of engineer draftsmen has recently been formed, having for its object the advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members. Besides holding regular meetings, at which professional papers will be read and discussed, there will be opportunities for social intercourse, an engineering library will be maintained, and also an employment bureau for the benefit of the members. The qualifications for membership are such that a standard will be established, and it is the aim of the society to maintain this standard and to secure recognition from concerns employing draftsmen. E. Farrington Chandler has been elected president, William B. Harsel vice-president, and Henry L. Sloan secretary and treasurer, with headquarters at 116 Nassau street, New York City.

The Boiler Maker

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Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Graphical Charts.

Any new departure which will tend to lessen or expedite the work of a layerout will no doubt be eagerly investigated by boiler shop foremen and superintendents. Many things, however, which are claimed to be new departures are in reality nothing but new applications of old principles, and undoubtedly many more such improvements would be made if men had not become so blinded by familiarity with old principles that they fail to see the possibility of new applications. An example of how old and well known principles may be applied in a new way to the ordinary work of a layerout is told in detail by one of our contributors this month, the new methods to which he calls attention being the use of graphical charts for the solution of boiler problems.

Graphical charts simply show the relation between two variable quantities for a certain range of values, but they show this relation in such a manner that its general character and tendency are evident at a glance, while careful and accurate reading of the chart will give correspondingly exact information regarding these quantities. The system of graphic diagrams which is described was originated by Descartes in 1637, and hence is called "The Cartesian System" in honor of its inventor, and the simple forms of this system which are outlined are the starting point of co-ordinate or analytic geometry. Many of the curves which are plotted on graphical charts can be represented by equations, and their solution then admits of algebraic and trigonometric treatment. On the other hand, some curves, such as that showing the relation between the temperature and pressure of steam, cannot be satisfied by any known equation. Whether or not the curves represented on the diagram can be treated mathematically will make very little difference to the boiler maker, since in general the mathematical treatment of such problems is complicated and requires considerable time for solution, whereas the whole purpose in using the charts is to save time and facilitate the actual shop operations.

Once a chart is made which represents accurately the relation between two variable quantities, such, for instance, as the horsepower and heating surface of a certain type of boiler whenever it is desired to find the heating surface for any size boiler of this particular type, it is not necessary to go to the trouble of calculating the area of the heating surface from the dimensions of the boiler. It is simply necessary to refer to the chart and read directly from the diagram the value of the heating surface for a boiler of the required horsepower. This one instance shows how useful such diagrams may become; and when it is remembered that these instances can be multiplied almost indefinitely, it is evident that it will well repay every boiler maker and layerout to study carefully the use of graphical charts and see how he can apply them to his own work.

Care of Pneumatic Tools.

Two useful articles on the care of pneumatic tools have been published in our columns recently. One of them appeared last month and the other will be found on page 270 of this issue. The authors of both these articles are experts who represent two of the largest pneumatic tool manufacturers in this country. Their experience and the results of their long and close observation enable them to speak with authority, and it will amply repay any user of pneumatic tools to study carefully their suggestions. The most severe abuses to which pneumatic tools are subject are neglect to properly clean and oil, operation under insufficient air pressure, and the use of tools unsuited to the work in hand. It will hardly seem necessary to caution a boiler manufacturer or foreman boiler maker who has under his care thousands of dollars' worth of machinery to beware of neglect in the care of pneumatic tools, yet unless care is exercised neglect will invariably creep in and immediately lower the efficiency of these tools. Where forty or more pneumatic tools are in use in a plant it is not only advantageous but economical to employ a man simply to look after these tools to see that they are properly cleaned and oiled every day, and that the pipe lines and hose are in good condition, free from leaks and clear of sediment. All pneumatic tools manufactured by reputable concerns are made of carefully selected materials, and extreme care is used in the manufacture, so that when the tools leave the shop they are capable of producing accurate and economical results. No tool, however, which has a multiplicity of moving parts and is delicately adjusted can be expected to hold up under continual use without a certain amount of wear. Whenever the wear becomes excessive the parts should be renewed, so that the original efficiency of the tool will be regained.

TECHNICAL PUBLICATIONS.

Hydraulic Elevators. By William Baxter, Jr. Size, 6 by 9 inches. Pages, 326. Figures, 260. New York, 1910: McGraw-Hill Book Company. Price, $2.50 net.

The design, construction, operation, care and management of various types of hydraulic elevators are carefully considered in a practical manner in this book. A large number of diagrams and illustrations serve to give the reader a comprehensive idea of the details of elevator construction and operation. It will be found particularly valuable as a work of reference for the engineer who has not specialized in such work, but who is sometimes confronted with problems requiring accurate knowledge of many of the details.

Manual of Steam Engineering. By W. H. Wakeman. Size, 3 by 5½ inches. Pages, 441. Numerous illustrations. New York, 1910: New York Belting & Packing Company, Ltd.

This book is primarily a reference book, containing data used in every-day engineering practice, arranged in convenient form, with sufficient explanation to render the matter both interesting and instructive. It contains many tables, which are arranged for use in connection with the reading matter on the same subject, thus condensing information into convenient space and rendering it available for busy workers. The author has had considerable experience as a technical writer, and this has enabled him to present the various subjects treated in an exceptionally clear and useful manner. The book is divided into two parts, one of which is confined to steam boilers and the other to steam engines.

American Producer Gas Practice and Industrial Gas Engineering. By Nisbet Latta. Size, 7½ inches by 10½ inches. Pages, 539. Illustrations, 247. New York, 1910: D. Van Nostrand Company. Price, $6 net.

This is by far the most complete work which has yet appeared on American producer-gas practice. That this branch of engineering has already reached immense proportions will undoubtedly surprise many to whom the subject of producer gas has been placed in the category of new developments. Not only for power apparatus but for a great number of varied industrial purposes has the gas producer now become an essential piece of apparatus. Any handbook, therefore, which attempts to cover the field completely soon reaches large proportions. Undoubtedly this book might have been made more concise; but at the same time the value of the data and careful treatment of each subject make it worth a careful study. The author states in the preface that the book was originally written with the urgent desire to maintain an impartial attitude, and to narrate as accurately as possible, without prejudice or undue influence, the various features of gas engineering at present in vogue in the industrial field. This naturally involves the description of a great many patented systems and pieces of apparatus, and where this has been done the description is placed before the reader, together with the method of operation or other data, for the purposes of giving information and drawing comparisons, leaving the reader to draw his own conclusions as to the value of the apparatus.

The early chapters of the book include producer operation; cleaning the gas; works details; producer types; moving gases; solid fuels; physical and chemical properties of gases and gas power. The subject of gas engines is treated briefly and from a general standpoint. The remainder of the book is taken up with a discussion of various industrial gas applications and a discussion of heat, combustion, furnaces, pipes, flues, chimneys, etc. The final chapter contains useful tables for use in gas engineering practice, while in an appendix oil fuel producer gas is briefly considered. As this is a more recent development the amount of data available is, of course, limited. This is a direction, however, in which it is very likely that considerable development will take place in the near future, and, therefore, any data appearing upon the subject from reliable sources are of considerable value and cannot be overlooked.

The Engineering Index Annual for 1909. Size, 6½ by 9¼ inches. Pages, 471. New York and London, 1910: *The Engineering Magazine.* Price, $2.

This book represents a continuation of that originally started by the late Prof. J. B. Johnson in the *Journal* of the Association of Engineering Societies in 1884, and turned over by that association to *The Engineering Magazine* at the close of 1895. Each year it has covered with increasing thoroughness the field of periodical literature in engineering and closely related applied sciences. This volume, which is the fourth since the publication has assumed the annual form, comprises a classified index to all engineering literature during the year. The classified plan of indexing, which has only recently been followed out, serves to combine for each specialist a list of the entire current literature on his subject, and to assemble it in such small space that it may be readily found and completely explored. The value of this work is obvious, and it is sufficient to say that the present volume has been edited with the same care and thoroughness as previous volumes, and that it has been made even more comprehensive.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—Please tell me which of the following formulas is the correct one to use for finding the allowable pressure on a spherical tank or boiler:

$$WP = \frac{TS \times t \times eff.}{R \times F}$$

$$\text{or, } WP = \frac{\text{Circumference} \times TS \times t \times eff.}{\text{Area} \times F}$$

where TS is the tensile strength of the metal; t, the thickness of plate; $eff.$, the efficiency of riveted joint; R, the radius of the tank and F the factor of safety.

The first formula is that for finding the allowable working pressure on a cylindrical tank and some claim that this same formula should be used in the case of a spherical tank. Which is right?

A.—The second formula which you quote, namely,

$$W\ P = \frac{\text{circumference} \times T\ S \times t \times eff.}{\text{area} \times F}$$

is the correct one to use. By substituting $2\ \pi\ R$ for the circumference in this formula and $\pi\ R^2$ for the area, the formula reduces to

$$W\ P = \frac{2 \times T\ S \times t \times eff.}{R \times F},$$

which you will note is just twice the value of the first formula. In other words, a spherical boiler or tank is twice as strong as a cylindrical one of the same diameter, thickness of plate, efficiency of joint, etc. Consequently, in a spherical tank the plate need be only one-half as thick as in a cylindrical tank.

Q.—What is meant by the efficiency of a boiler? J. M. C.

A.—The efficiency of a boiler is the ratio of the number of heat units supplied by the boiler in the steam generated to the number of heat units supplied to the boiler in the fuel. For instance, if a boiler test shows that 11,500 heat units are required to evaporate 9 pounds of water from and at 212 degrees in a certain boiler, the efficiency of the boiler is 75.5 percent, since only 8,733.6 heat units are required to evaporate 9 pounds of water from and at 212 degrees.

COMMUNICATIONS.

Door-Hole Flanges on Locomotive Fire Boxes.

EDITOR THE BOILER MAKER:

Fire-box holes are not flanged uniformly, and many different shapes and sizes are used. It is the opinion of the writer that it would save a great deal of patchwork if these holes were made round with the fire-box head flanged out and the boiler head flanged in, fitting outside. This is the most uniform type of construction and would not be so liable to crack. If a rectangular door is used with corners having 2¼-inch radius, and the sides and top and bottom flanged straight, the corners are too rigid for the straight flanges and are liable to cause cracks and leaks.

Door-hole flanges should be made as nearly an accurate fit as possible without having to change the set in the heel of the flange, but, if a heat must be taken to make flanges fit, it should be done with a charcoal heater in order not to injure the metal. A heater made with a 16-inch cylinder lined with asbestos tapered down to a 2½-inch pipe for the inlet of air and discharge of heat is, in the opinion of the writer, a much better heater than a gasoline heater, as regards prolonging the life of the sheets. If flanges are heated with distillate or gasoline, the sulphur in the fuel tends to crystallize the metal, so that after these fire-boxes have been in use for a short time they will crack and require patching or plugging. Also a great deal of repair can be saved by making the flanges long enough to allow a 4-inch or 5-inch water space. This allows a better circulation of water, and also gives the sheets more chance to expand and contract, and usually will tend to lengthen the life of the fire-box. JOE HOLLOWAY.

How to Find the Capacity of the Tank of a Locomotive Tender.

EDITOR THE BOILER MAKER:

Required the capacity in imperial gallons of a locomotive engine tender tank of the following dimensions:

Depth, 2′ 8″, or 32″.

Length or distance between *A* and *B* 10′ 2¾″, or 122.75″.

Breadth or distance between *c* and *b* 6′ 7½″, or 79.5″.

Length or distance between *g* and *G* 3′ 10¾″, or 46.75″.

Mean breadth of coke space *L* and *M* 3′ 1¼″, or 37.25″.

Diameter of circle *P* and *S* 1′ 6½″, or 18.5″.

Radius of back corners *v* and *x* 4″, or 4″.

Then $122.75 \times 79.5 = 9758.525$ square inches, as a rectangle, and $(18.5)^2 \times .7854 = 268.8$ square inches area of circle formed by the two ends. Total, 10027.325 square inches, from which deduct the area of the coke space and the difference of area between the semi-circle formed by the two back corners and that of a rectangle of equal length and breadth. Then $46.75 \times 37.25 = 1731.4375$ area of *R, N, S, T* in square inches.

$$\frac{(32.25)^2 \times .7854}{2} = 408.4 = \text{area of half the circle } R, N.$$

Radius of back corners = 4 inches; consequently $(8)^2 \times .7854 = 25.13$, the semi-circle's area and $8 \times 4 = 32 - 25.13 = 6.87$ inches taken off by rounding the corners. Hence, $1731.4375 + 408.4 + 6.87 = 2146.707$, and $10027.325 - 2146.707 = 7880.618$ square inches, or whole area in plan 7880.618×32 (the depth) $= 252179.776$ cubic inches, and $252179.776 \times .003607 = 909.61245$ gallons.

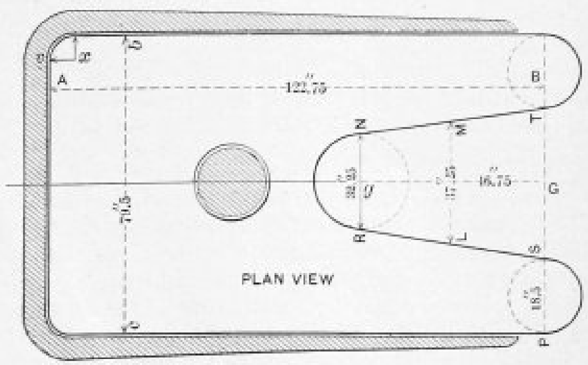


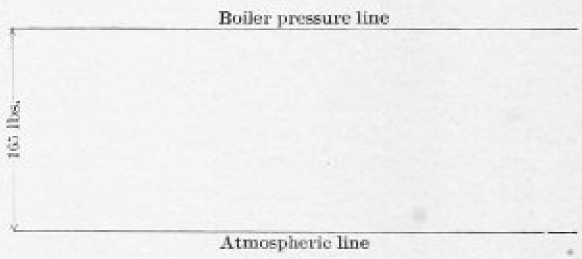
DIAGRAM SHOWING TANK OF LOCOMOTIVE TENDER.

Indicating a Boiler.

EDITOR THE BOILER MAKER:

It not infrequently happens in plants having a number of boilers in a battery or series of batteries, each fitted with from one to four safety valves and one steam gage, that there is a difference of from one to five pounds pressure in the point at which the safety valves lift. This means that the valve having the spring with the lightest tension will be the one that lifts whenever the steam reaches a higher point than that set for safety, and, in many cases, some safety valves are never lifted unless by some mechanical means installed for that purpose.

At the same time, perhaps, no two steam gages in the plant show the same pressure or correspond with the point of blow-off of the safety valves. This, of course, is not a desirable condition. The obvious and proper thing to do would be to summon an inspector, who, with a test gage, would set each safety valve on each boiler separately, and correct the error in the steam gages.



INDICATOR CARD FROM A BOILER.

But in cases where a test gage is not immediately available the same desired result can be obtained by means of an engine indicator by the following method:

Having ascertained that the indicator is perfectly accurate, have pipe fittings of a suitable size connected to the steam space of each boiler. Cut out the boiler, having valves to be tested, from the battery, gag all safety valves on that boiler except the one to be tested. Attach the indicator in the usual manner, after having blown steam through the pipes to clear any dirt or grit that may have been in them. Raise steam slowly in the boiler until it reaches the blowing-off point. Then, after placing the paper on the drum of the indicator in the usual manner, open the cock to the atmosphere, and, while holding the pencil against the paper on the drum with one hand, pull the cord with the other hand, thus drawing the atmospheric line. Then, after the indicator has been properly warmed by admitting and releasing steam to the cylinder by means of the cock, open the cock full, admitting the full boiler pressure, then draw a second line in the same manner as before described. This line will be the boiler pressure line. Then by measuring with the scale suitable for the spring used on the indicator, the distance between the two lines will give the pressure on the boiler at the point at which the valve being tested blows off. If no scale is available, measure the distance between the lines in inches and fractions thereof, and multiply by the number of the spring used on the indicator.

This operation can be done in a very few minutes, and as each valve is corrected the reading of the steam gage on the corresponding boiler should be noted and corrected, the operation to be repeated on each valve of each boiler until each valve blows off at the point allowed by law, and each steam gage gives an accurate reading. W. K. Q.

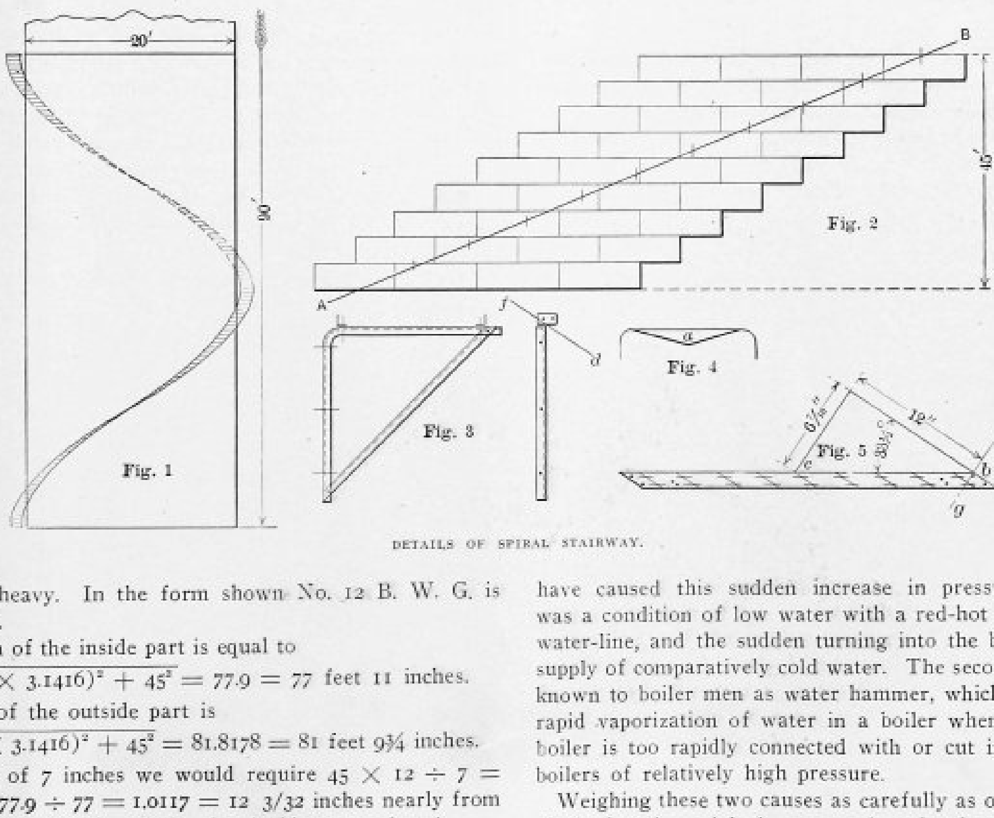
Layout of a Spiral Stairway.

EDITOR THE BOILER MAKER:

The sheet metal draftsman is often called upon to layout unusual jobs. The writer will describe one that is often used on standpipes, water softeners and sometimes in buildings.

Fig. 1 shows half a standpipe, 20 feet by 90 feet with a stairway 18 inches wide, the inside being 3 inches from the pipe. Fig. 2 is the layout of half of the standpipe. The line *A B* shows where the supports (Fig. 3) can be located, so as to keep clear of the vertical and girth seams.

Fig. 4 shows the form of a step usually used. The lip *a* provides stiffening, as without it the iron would necessarily



DETAILS OF SPIRAL STAIRWAY.

have to be heavy. In the form shown No. 12 B. W. G. is usually used.

The length of the inside part is equal to

$$\sqrt{(20.25 \times 3.1416)^2 + 45^2} = 77.9 = 77 \text{ feet } 11 \text{ inches.}$$

The length of the outside part is

$$\sqrt{(21.75 \times 3.1416)^2 + 45^2} = 81.8178 = 81 \text{ feet } 9\tfrac{3}{4} \text{ inches.}$$

With a rise of 7 inches we would require $45 \times 12 \div 7 = 77 +$ steps; $77.9 \div 77 = 1.0117 = 12\ 3/32$ inches nearly from center to center of rivet holes for inside part of stairway; $81.8178 \div 77 = 1.0626 = 12\tfrac{3}{4}$ inches from center to center of rivet holes for outside part of stairway. The calculations are for one-half of the job.

To lay off the rivet holes for this step (33½ degrees) with the 12-inch mark of the square on the point *b* and the 6 7/16-mark on the point *c*, draw the line, which is the shear line shown, but the same marks are used to locate the rivet holes.

It will be seen that the angle on the support, Fig. 3, is to one side, so as to clear the stairway *d f*. On this form of a stairway there is usually a hand-rail not shown. A piece of 1¼-inch pipe makes a good hand-rail. To roll the pieces for the stairway, Fig. 5, they must be passed through the rolls on line *g h*. SUBSCRIBER.

Water Hammer the Cause of the Canton Boiler Explosion.

EDITOR THE BOILER MAKER:

According to the verdict of Coroner Harry A. March, the boiler explosion which occurred last May at the plant of the American Sheet and Tin Plate Company, Canton, Ohio, causing 13 deaths and many injuries, was due to water hammer. The boiler which exploded was 15 years old, of the cylindrical lap-seam type, 5½ feet in diameter and 16 feet long. During the 15 and a half years of its existence this boiler was inspected at regular intervals by representatives of a well-known and reliable insurance company, the last inspection having taken place 11 weeks before the explosion, when the boiler was deemed safe for a pressure of 95 pounds per square inch. The safety valves for the battery of which this boiler formed one unit popped at 100 pounds pressure, thus insuring safety under ordinary circumstances. Therefore, it is evident that the cause of this sudden explosion must mave been some sudden and unusual increase of pressure.

Two possible conditions, it is claimed by the Coroner, could have caused this sudden increase in pressure. The first was a condition of low water with a red-hot boiler above the water-line, and the sudden turning into the boiler of a large supply of comparatively cold water. The second is a condition known to boiler men as water hammer, which consists of the rapid vaporization of water in a boiler when a low pressure boiler is too rapidly connected with or cut into a battery of boilers of relatively high pressure.

Weighing these two causes as carefully as one without technical education might be expected to do, the Coroner came to the conclusion that the explosion was due to water hammer while the boiler was being cut into the battery. This conclusion was based partially upon the fact that the stop-valve was found two-thirds open, indicating that the boiler had been only partially connected to the other boilers when the explosion occurred.

In rendering this decision, the Coroner disregarded the opinions of several well-known boiler experts. Nevertheless, he feels certain that his opinion will be justified by any who investigate the case from an impartial standpoint. E.

PERSONAL.

J. A. THORNTON, formerly foreman boiler maker of the L. & N. Railroad at New Decatur, Ala., has been appointed foreman boiler maker of the Kansas City, Mexico & Orient at Fairview, Okla.

W. N. STARK has been made foreman boiler maker of the Kansas City Southern, taking the place made vacant by H. E. Jones, who has been assigned to other duties.

H. S. WHITE has been appointed sales manager of the Detroit Seamless Steel Tubes Company, Detroit, Mich.

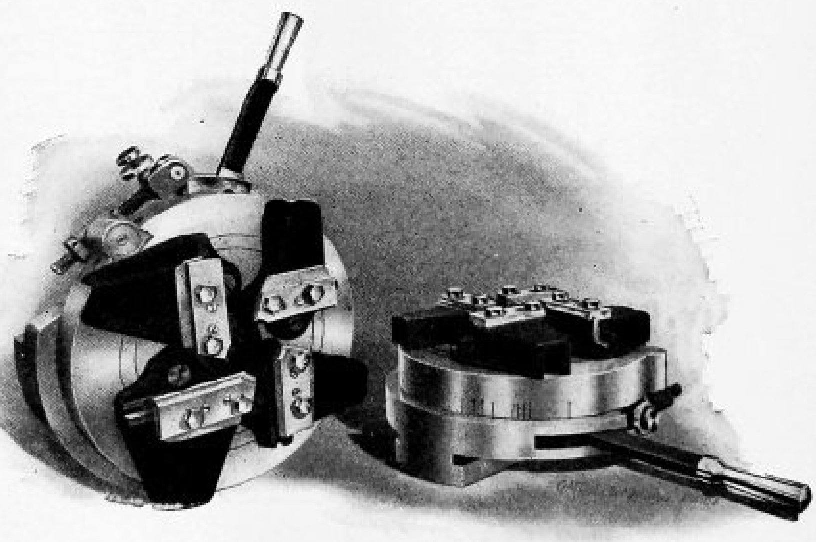
ALBERT SPIES, for many years editor of *Cassier's Magazine* and recently proprietor and editor of the *Foundry News*, died August 16 at his home in Jersey City, N. J.

THE MANY FRIENDS of Mr. Louis M. Henoch, who has been identified with the iron and steel trade for many years, and lately connected with the Carnegie Steel Company, will be pleased to note that he has identified himself with the Scully Steel & Iron Company, of Chicago, as treasurer of that concern. THE BOILER MAKER takes this opportunity to congratulate both Mr. Henoch and the Scully Company upon this connection.

ENGINEERING SPECIALTIES.

Stationary Die Head for Pipe Threading.

A stationary die head for pipe threading is being manufactured by the Landis Machine Company, Waynesboro, Pa., in which the Landis type of die is used with a manually-operated die head. This head is made especially for use on pipe-threading machines, wherein the pipe revolves and the head remains stationary, the dies being opened and closed by hand.



The head is made entirely of steel as are also the die holders. The chasers for the heads can be made to good advantage from high-speed steel, as it is claimed that they never require to be annealed, rehobbed or retempered, and that they have the further advantage of long life. The sharpening of the die is a simple operation, and is taken care of by grinding on the ends of the chasers and again setting them to the correct cutting position in the holders by means of a small gage furnished with the die head. The heads are made in standard sizes to take work up to and including 4 inches. One set of dies will cut all the diameters coming within the same pitch. As there is but one pitch covering the sizes from 1 inch to 2 inches, inclusive, one set of dies covers this range. The same is true on the other pitches.

Special holders are made for pipe threading where it is not necessary to cut very close to a shoulder. The clamp with which this chaser is held is what is known as a mill clamp,

which besides holding the chaser rigidly protects the chaser in case the pipe splits. The clamp comes down over the throat of the die, and is rounded out near the cutting point, so as to act as a guide for rough ends, and at the same time when a twister occurs in the pipe the strain is thrown in great part on the clamp, thus protecting the die in such manner that the liability of breakage is very small. In case of threading close to a shoulder a clamp is used which comes flush with the front edge of the chaser only, thus permitting the die to run close up against the shoulder as in threading short nipples, etc. It is claimed that these dies admit of cutting speeds from 25 to 100 percent higher than the hobbed type of die, and that the rake can at all times be ground to suit the quality of the material in the pipe to be threaded.

The heads are graduated for setting the dies to the different diameters to be threaded. The head is opened and closed by hand, and when in the closed position the die is rigidly locked, but opens and closes freely by means of the lever. All dies are made to interchange, and if one chaser of a set should be worn out in advance of the others this single chaser can be replaced without replacing the entire set. Dies of any one pitch will interchange on any of the die heads so long as the pitch is within the range of the head.

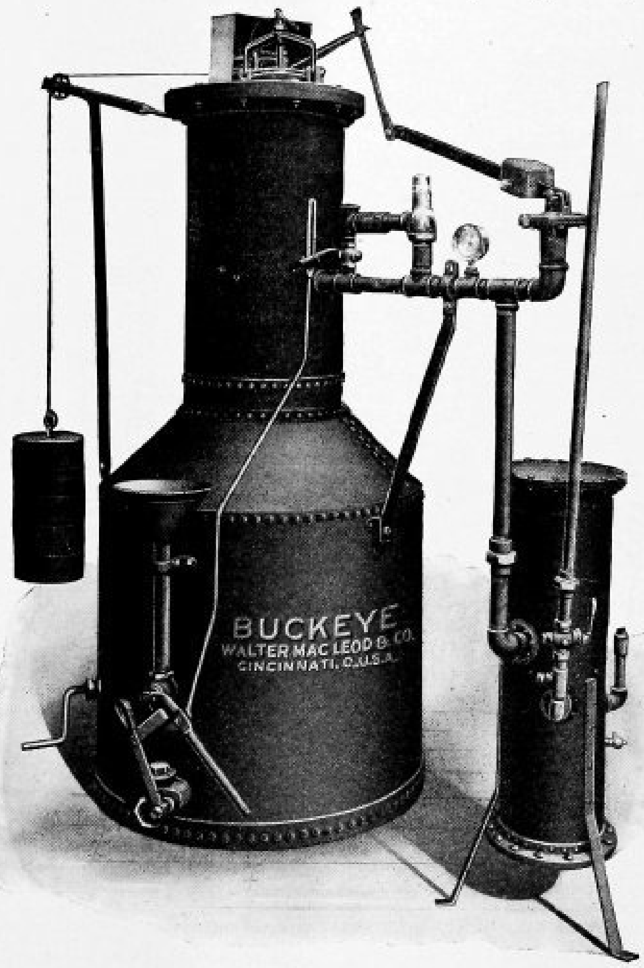
The heads are made in standard sizes as follows: From ¼ to 1 inch, inclusive; from ¼ to 1½ inches, inclusive; from ½ to 2 inches, inclusive; from 1 to 4 inches, inclusive.

The Buckeye Oxy-Acetylene Welding and Cutting Apparatus.

Walter Macleod & Company, Cincinnati, Ohio, have placed on the market a complete oxy-acetylene welding and cutting plant, consisting of an acetylene generator, an oxygen generator, a torch with a variety of tips allowing a range for welding from 22-gage steel up to 2-inch cast iron or ¾-inch steel. The outfit also includes an oxygen reducing valve, an acetylene reducing valve, hose, goggles, etc. This plant, of course, is a stationary one, and for portable work they supply compressed (dissolved) acetylene in cylinders. The oxygen generating apparatus is adapted either for portable or stationary apparatus.

The oxygen generator consists essentially of three parts, namely: a retort with a furnace, the scrubber and the receiver. The furnace is a sheet-iron receptacle lined with asbestos having a perforated bottom, folded top and hinged door, so arranged as to use charcoal, coke, oil, gasoline or gas, as desired. In the furnace is placed the retort, which consists of a strong wrought iron or steel receptacle tested to the maximum pressure, one end of which is permanently closed by a solid plate, the other end being closed by a removable cap. It is fastened inside the furnace in such a position as to get the full benefit of the heat generated by the fuel used. Supplied with the retort are three sheet-steel pans in which the compound from which the oxygen is made is placed. Securely attached to the upper portion of the fixed end of the retort is a small heavy pipe-line, along which is fitted a safety valve, pressure gage unions and valves. The pipe-line leads to the scrubber, which is provided with the necessary cleaning and filtering devices. The oxygen is then led to a receiver, consisting of a compressed air seamless tank, varying in size and strength according to the pressure required and capacity of the plant. The process of generation consists simply of filling the pan with the necessary compound, placing it in the retort and closing same. The compound consists of two chemicals, which can be purchased from any manufacturing chemist, or can be supplied by the manufacturers.

The acetylene generator, a cut of which is shown herewith, is built in sizes from 10 to 200 pounds capacity, and is of the carbide-feed type. The gas is washed before passing to the receiver chamber, and the excess of water prevents overheating in case of excessive demands. The weight of the carbide does not rest directly on the feeding device; thus it is claimed the danger from sticking or dropping of carbide, causing over-generation, is obviated. It is also claimed that the regulation is very close, and that the pressure can be set at any point from zero to 15, which is the maximum.



A safety valve of ample capacity is provided and a simple automatic device causes all the gas to be emptied from the receiving chamber before it can be washed out. In addition to the gas being washed in the generating chamber, a filter is provided and a second washing occurs in the hydraulic flash-back chamber.

The torch weighs less than two pounds, and, due to the large number of tips provided and to the efficiency of the design, it is claimed to be very economical and to admit of close regulation, practically eliminating flash-backs.

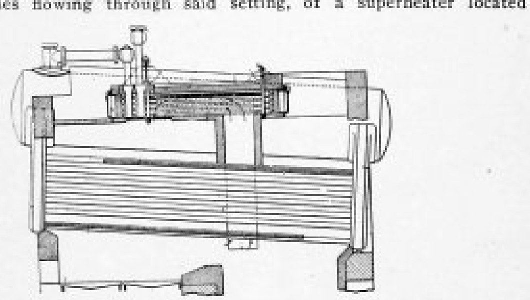
SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

963,732. STEAM SUPERHEATER. ERNEST H. FOSTER, OF NEW YORK, N. Y.

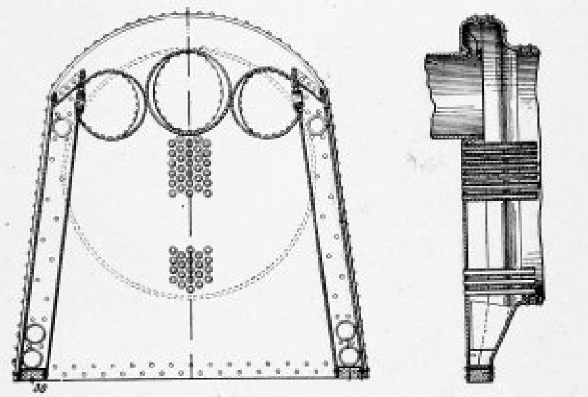
Claim 1.—The combination with a boiler settting and furnace, and a water-tube boiler having its water tubes arranged in the path of the furnace gases flowing through said setting, of a superheater located



above the water tubes, and one or more flues or conduits in the side walls of the setting, extending from the furnace and discharging hot gases therefrom upon the superheater. Four claims.

963,627. FIRE-BOX FOR BOILERS. JAMES M. McCLELLON, OF EVERETT, MASS.

Claim 3.—A fire-box comprising, in combination, a plurality of upright seamless integral side-wall sections presenting outer and inner oppositely convexed flexion sides and flat sides, the latter being secured



to one another substantially throughout their lengths; a crown chamber with which said integral sections communicate at their upper ends and to which they are secured; and means closing said sections at their lower ends, the whole providing structural stability of the fire-box combined with unit flexibility. Twenty-five claims.

963,602. SMOKE-PREVENTER. LATIMER H. LONG, OF LOUISVILLE, KY.

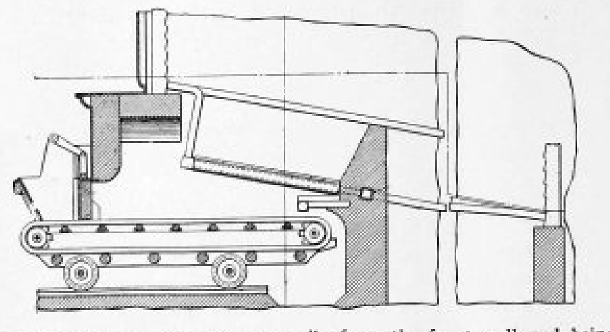
Claim.—A smoke preventer for furnaces, comprising air and steam inlets forming a siphon jet, a bar for controlling the admission of steam and air therethrough, means for moving said bar to slowly cut off the steam and air when opened, and a lever for moving said bar to open the steam and air pipes, said lever lying in the path of the furnace door to be actuated thereby when opened, and being formed with a hinge intermediate its length whereby it may be folded out of the path of movement of said door when desired. One claim.

964,031. LIQUID HYDROCARBON-BURNING APPARATUS. LOUIS K. LEAHY, OF LOS ANGELES, CAL.

Claim 1.—A liquid hydrocarbon-burning apparatus, comprising a combustion chamber having an end wall provided with an opening, an ignition chamber communicating with the combustion chamber through said opening, an air supply chamber surrounding the ignition chamber and adjoining said wall and adapted to communicate with the combustion chamber, means for injecting atomized liquid hydrocarbon into the ignition chamber, and spring pressed means at the rear of the combustion chamber for automatically relieving excessive pressure at the time of ignition. Two claims.

964,053. STEAM-BOILER FURNACE. HERMAN A. POPPENHUSEN, OF EVANSTON, AND JOSEPH HARRINGTON, OF RIVERSIDE, ILL.

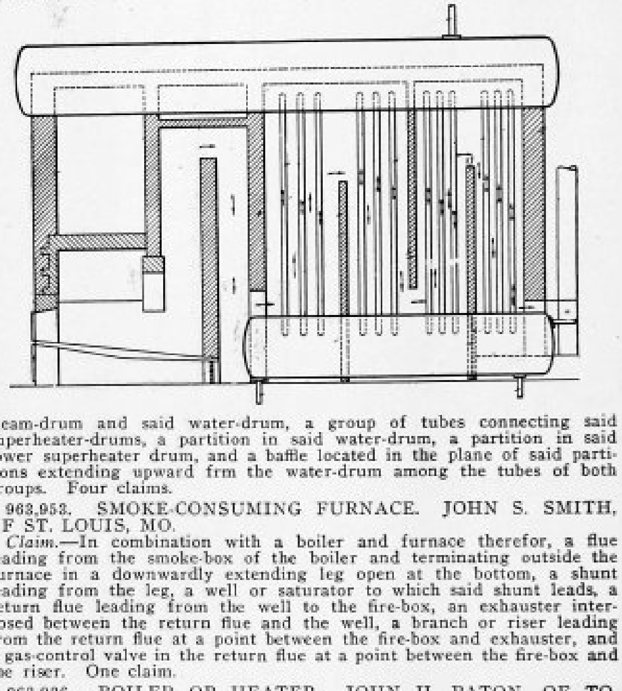
Claim 1.—The combination with the masonry bridge wall, front wall and side walls of the furnace, and a grate, of a deflecting partition extending forwardly from the bridge wall and dividing the combustion chamber into upper and lower compartments connected with each other at the front of the furnace, said partition embracing a plurality of tubular, water-cooled supporting members, the rear ends of which are embedded in the bridge wall and which extend forwardly from said bridge wall toward the front of the furnace, a transverse header connected with the forward ends of said supporting members, said header



being located at a distance rearwardly from the front wall and being supported at its ends by the side walls, and fire brick members which surround, completely cover and span the spaces between the said tubular supporting members, said fire brick members extending continuously between the bridge wall and said header. Five claims.

963,257. SUPERHEATING BOILER. ALISON B. STIRLING, OF PLEASANT MOUNT, PA.

Claim 4.—In a superheating boiler, the combination with the furnace, of a water-drum, a steam and water-drum disposed above the water-drum, uper and lower superheater drums located above said steam and water-drum and connected therewith, a group of tubes connecting said



steam-drum and said water-drum, a group of tubes connecting said superheater-drums, a partition in said water-drum, a partition in said lower superheater drum, and a baffle located in the plane of said partitions extending upward frm the water-drum among the tubes of both groups. Four claims.

963,953. SMOKE-CONSUMING FURNACE. JOHN S. SMITH, OF ST. LOUIS, MO.

Claim.—In combination with a boiler and furnace therefor, a flue leading from the smoke-box of the boiler and terminating outside the furnace in a downwardly extending leg open at the bottom, a shunt leading from the leg, a well or saturator to which said shunt leads, a return flue leading from the well to the fire-box, an exhauster interposed between the return flue and the well, a branch or riser leading from the return flue at a point between the fire-box and exhauster, and a gas-control valve in the return flue at a point between the fire-box and the riser. One claim.

963,936. BOILER OR HEATER. JOHN H. PATON, OF TORONTO, ONTARIO, CANADA.

Claim 2.—A boiler or heater comprising an outer shell, a tapered feed header, a tapered flow header, a plurality of tubes connecting said headers, part of said tubes having inner concentric pipes surrounded by their annular spaces or interstices, said inner pipes having the ends thereof sealed flush with the adjacent walls of the headers, inlet conduits at one end of said sealed pipes and outlet conduits at the opposite end of said sealed pipes, said conduits extending perpendicularly to the pipes and supporting the pipes within the tubes, a plurality of superimposed alternately arranged baffle plates between the headers, and an outlet aperture in the outer shell below the top of the feed header whereby the heat will be drawn down the rear wall of the feed header before escaping. Three claims.

964,938. CHOPPER. JAMES REAGAN AND WILLIAM REAGAN, OF PHILADELPHIA, PA.

Claim 1.—In a device of the character stated, a supporting bar, a series of choppers each having a seat, a sleeve for each of said choppers longitudinally movable on said bar and laterally with respect to said choppers and held against rotation with respect to said bar and seated in a seat, each sleeve locking a chopper to the supporting bar and having means co-operating with a chopper whereby relative rotary movement between the sleeve and choper is prevented and the latter is actuated when the supporting bar is actuated. Five claims.

964,937. LIFTING FIRE-BAR. JAMES REAGAN AND WILLIAM REAGAN, OF PHILADELPHIA, PA.

Claim 2.—In a shaking grate, a supporting bar, a series of hollow lifting fire bars each having a bearing, means for actuating said lifting fire-bars, and a sleeve for each of said lifting fire-bars mounted on said supporting bar and seated in a bearing, each sleeve locking a lifting fire-bar to said supporting bar in the normal position of said supporting bar and adapted to release the said lifting fire-bar so that it can be withdrawn laterally from the supporting bar when said supporting bar is rotated out of normal position. Six claims.

THE BOILER MAKER

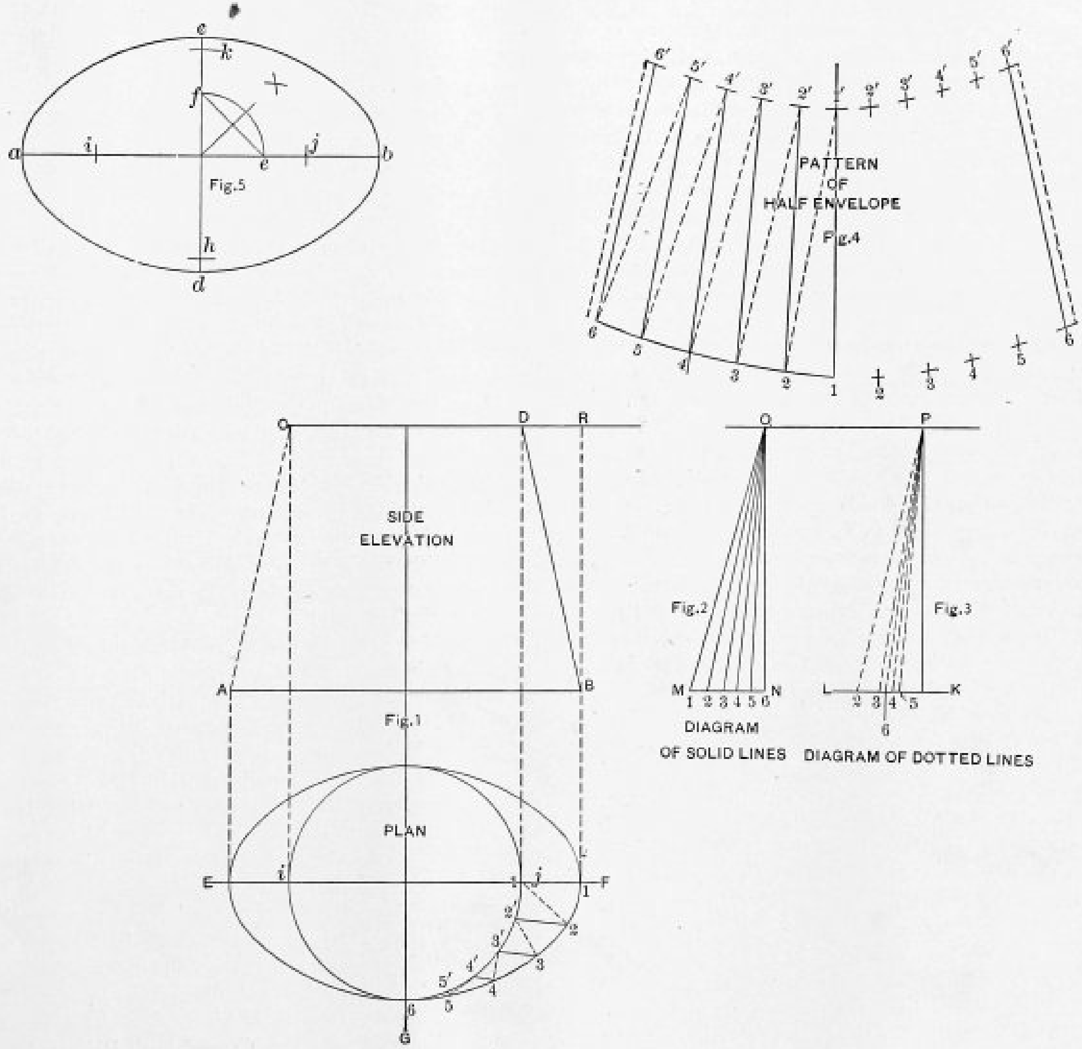
OCTOBER, 1910

TRIANGULATION APPLIED TO THE LAYOUT OF A TRANSITION PIECE.

BY JOHN COOK.

The following plan is one I use in getting out a pipe with an elliptical base and round top: In Fig. 1 the elevation of the article is shown by *A B D C*. In the plan, *E H F G* represents the elliptical base and *i H j G* the circular top. An inspection of the plan will show that the part represented by the top into the same number of spaces as indicated. Connect the points by solid and dotted lines, as shown.

The next step preparatory to obtaining the pattern will be to construct triangles whoses bases are equal to the lengths of lines drawn between points on *F G* and *j G*, whose altitudes



DIAGRAMS FOR LAYOUT OF TRANSITION PIECE BY TRIANGULATION.

F j G is similar to the other parts, consequently the pattern for one of these parts, as *F j G*, will answer for the others.

The method most convenient to employ for obtaining the proper shape is that of triangulation. For this purpose divide *F G* into any convenient number of equal parts, as shown by the small figures on *F G*. In the same manner divide *j G* of

are equal to the straight heights of the article and whose hypotenuses will give the correct distance from the points on *F G* to the points on *j G*. The diagram of triangles represented by the solid lines is shown in Fig. 2. To obtain these triangles, draw a horizontal line any convenient place, and from *N*, as shown, erect a perpendicular line, and make it the same height as *B R*, Fig. 1, represented by *O*, Fig. 2, in the drawing. Measuring in each instance from *N* on *N M*, set off the length of solid lines drawn between *F G* and *j G* in the plan, thus making *N M* equal to 1 1′ in the plan, *N* 2 equal to 2 2′ in the plan, *N* 3 equal to 3 3′ in the plan, etc. Having established the various points, lines can be drawn, as shown, from the points to *O* (but it is not absolutely necessary if the points are well defined); then the hypotenuses of the triangles in the diagram give the true distances between the points on *F G* of the base and the points on *j G* of the top as indicated by the solid lines in the plan.

The triangles shown in Fig. 3 are constructed in the same manner, and are derived from the dotted lines in the plan. *K P* represents the straight height of the article. Then on *K L*, Fig. 3, measuring in each instance from *K*, set off the lengths of the dotted lines; thus make *K* 2 of the diagram equal to 1′ 2 of the plan, *K* 3 of the diagram equal 2′ 3 of the plan, etc. Having established the various points on *K L*, draw lines to *P*, as shown. The hypotenuses of the various triangles in Fig. 3 are equal to the correct distances measured on the finished article between the points *F G* and *j G* of the plan, as indicated by the dotted lines.

In working this or any other article by triangulation it will be found very convenient to have two pairs of dividers, one pair for large spaces on *F G*, and the other for the smaller spaces on *j G*, thereby avoiding chances of error in resetting, and if two sets of trams were used, one for the solid lines and one for dotted lines, it would save time. For the pattern, begin by drawing a line as 1 1′, Fig. 4, on which set off a distance equal to *M O*, Fig. 2, which equals *B D* in the elevation, or 1 *O* in the diagram of solid lines, Fig. 2. Then with the dividers set to the large spaces on *F G*; scribe arcs on each side of 1, as shown at 2 2, using the point 1 as a center with the trams set from *P* to 2, Fig. 3. Carry to Fig. 4, and using 1′ as a center scribe arcs, cutting those just made, which establish the points 2 2 in the pattern at the bottom. Now set the trams from *O* to 2, Fig. 2, and using 2 2 as centers scribe arcs at the top. Then use the dividers set to the small spaces on *j G*, and using 1′ as a center scribe arcs, cutting the arcs made with the trams, and establish the points 2′ 2′ as shown at the top. Then using the dividers, set to the large spaces, scribe an arc from the point 2 to 3; set the trams from *P* to 3, Fig. 3, and with 2′ and 2′ as centers scribe arcs, cutting the arcs just made, and establish the points 3 3. Now, using the small dividers and 2′ and 2′ as centers scribe arcs. Set the trams from *O* to 3, Fig. 2, and with 3 and 3 on the pattern as centers scribe arcs, cutting these just made from 2′ and 2′, and we have the points 3′ 3′. Continue in this manner until the various points on *M N* and *L K* are located. Connect these points, and the pattern for part of the envelope as shown in Fig. 4 will be made.

Fig. 5 shows an easy plan to get an ellipse. Draw the diametrical lines at right angles to each other, intersecting at *o*. Set out the length and breadth of the figure on these lines equally from the center *o*; set off the length *o c*, or *o d*, with the compasses on the longer diameter from *b* to *e*, and with *o* as a center, with the radius *o e* describe the quadrant *e f*. Draw the line or chord *e f*; set off half of it from *e* to *j*, and with *o j* as a radius scribe arcs on the diametrical lines as at *j h i k*. Then *j* and *i* are the centers for the segmental arcs at *a* and *b*, and *h* and *k* are the centers for the lateral arcs at *c* and *d*. This is a very convenient way to get out an elliptical base, although it is, of course, not a new method.

The Standard Boiler Works, which recently installed a floating electric welding equipment, report the following: Welded the furnaces on the tugs *Argo* and *Tillicum*; the furnaces on the *Admiral Sampson* and the fire-boxes on a locomotive of the Marysville & Northern, and also on one belonging to the Three Lakes Lumber Company. The new equipment is proving very popular and the work successful.

BOILER CONSTRUCTION AND PRACTICE.

In a report prepared for the International Railway Congress by Mr. H. Fowler, works manager of the Midland Railway of England, and Mr. L. Archbutt, chemist of the same road, we find some interesting remarks on locomotive boiler repairs. Among other things the reporters say the general practice in keeping records of boiler repairs is to make written notes of the work done, but the Western Austrialian government railways and the Southern Mahratta railways make sketches indicating the nature of the repairs as well as written particulars.

The report indicates that the authorities of several of the railways sending in replies are of the opinion that a more liberal spacing of the tubes near the edges of the tube plate and not allowing the tubes to come very near the edge of the plate, tends to prevent cracking of the plate flanges, and it also tends to save the bridges near the flange of the plate. This permits of an increased radius in the plate corners, prevents cracking and grooving. Increase of water spaces provides means for better circulation and reduces breaking of stays and corrosion.

The Great Eastern Railway uses a 1/16 copper liner between mud-ring and outer fire-box sheet (steel) and this copper liner is the full depth of the mud-ring and extends several inches up into the water space. This prevents grooving near the mud-ring, and the internal angle-iron used to connect the smokebox tube plate with the barrel of the boiler is said to prevent grooving. Steel tubes have been used on a number of roads in order to lessen corrosion due to galvanic action. The Cape Government Railway officials state that grooving is more pronounced in boilers with brass tubes than in those using steel tubes.

The Cape Government Railways and the Lancashire and Yorkshire officials say that increasing the width of the water spaces round the fire-box has a good effect in preventing cracks, pitting and grooving. The Cape Railway, with shallow fire-box, provides a 4-inch space at the bottom, flaring out to 5 or 6 inches at the top, and this has been found very beneficial. With fire-boxes placed between the frames there has been some tendency to decrease the grate area in order to secure a similar result.

In washing out, the use of cold water is the general practice, though many roads are considering the advisability of using hot water. Six roads get the hot water they require by means of an injector, while others use stationary boilers. When the boiler is refilled hot water is, of course, used at a temperature of about 180 degrees F. The average mileage between washouts varies from 300 to 1,650 miles, depending on the quality of water used. The time allowed for cooling down of boilers varies from three to twenty-four hours, eight hours being the usual thing.

From twenty to twenty-five roads used scum cocks, but on some their use has been discontinued, because of the danger of their sticking open and causing delay, notably on the Oudh & Robilkhand Railway in India. The London, Tilbury & Southend Railway use their blow-off cocks every 500 miles. The usual position for the blow-off cock is immediately above the mud-ring and in the throat sheet, on the center line of the fire-box. The Western Australian government railways have their scum cocks on the back sheet on the left of the fire-box, 3 inches above the crown sheet, with pipe suitably arranged. Thirteen railways answering the inquiry of the reporters state that they admit feed water at the middle of the barrel, and eleven have it enter near the smokebox tube plate.—*Railway and Locomotive Engineering.*

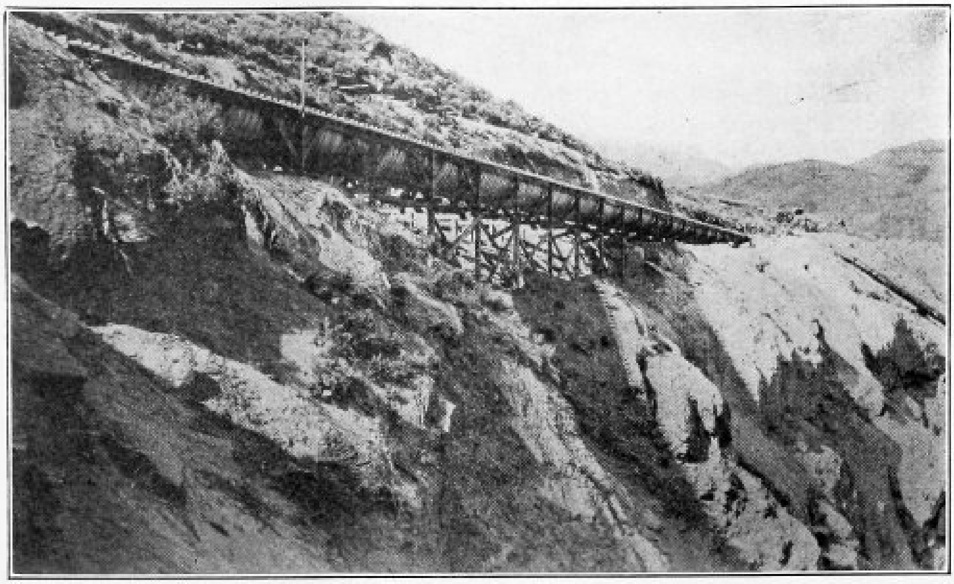


FIG. 1.—DOUBLE-CHANNEL FLUME IN THE PAYETTE VALLEY.

NOVEL IRRIGATION FLUMES OF GALVANIZED SHEET STEEL.

BY FRANK C. PERKINS.

In the various irrigation projects in Idaho galvanized sheet steel flumes have recently been utilized to great advantage. The accompanying illustration (Fig. 1) shows the construction of a double channel flume erected in the Payette Valley near Emmett, Idaho, having a diameter of 9 feet. This galvanized steel flume was erected by the Canyon Canal Company, the total length of the flume being 1,200 feet and the grade 5.64 feet per mile, with a capacity of 275 cubic feet of water per second. These large flumes are made from galvanized steel sheets 14 feet long and 30 inches wide without the use of rivets or solder.

The joints are said to be absolutely water tight, the expansion and contraction being taken care of in each joint with no provision other than the general construction of joints.

The accompanying illustration (Fig. 2) shows a galvanized steel flume of the same construction, having a diameter of 9 feet, as erected near New Plymouth in the Payette Valley by the Farmers Co-operative Irrigation Company. It is maintained that the durability of these flumes is exceptionally good and the cost of construction is remarkably low for the capacity obtained.

EVAPORATION IN STEAM BOILERS.

BY JOHN CREEN.

The quantity of steam generated in a given boiler will depend, in the first place, on the quality of the fuel burned in the furnace and on the quantity consumed, and in the second place on the capacity of the boiler for absorbing and transmitting the heat generated. The quantity of fuel consumed depends on the area of the grate and the draft or flow of air into the furnace.

The efficiency of the furnace depends on its capability of burning with as little waste as possible the whole of the fuel in it, and that without superfluity of air; also, to produce perfect combustion there must be as little waste of heat

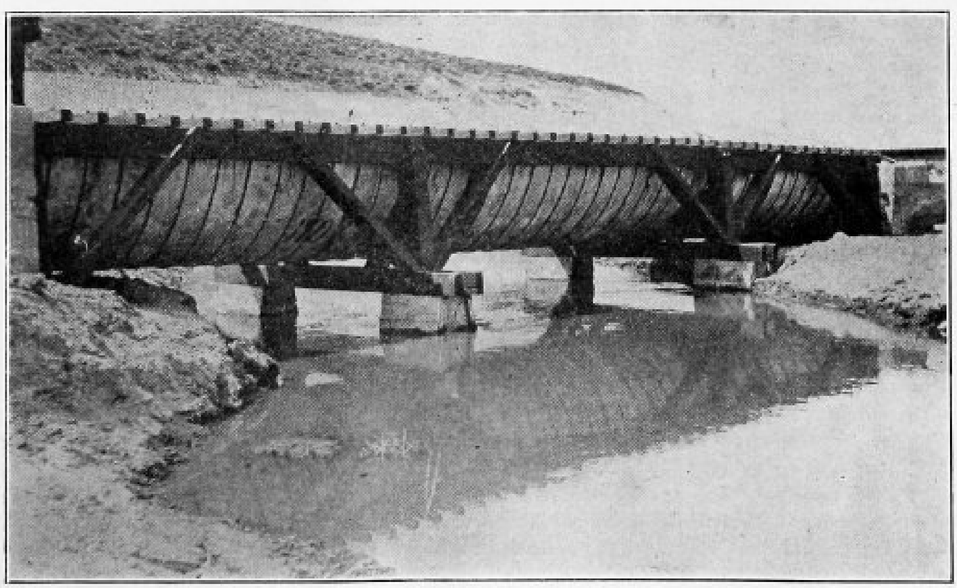


FIG. 2.

as possible in obtaining the necessary draft; that portion of heat generated which is applied to the production of steam is called the "available" heat. Every-day experience proves that a grate may consume a large quantity of fuel without thoroughly burning it, and that even when the fuel is thoroughly burnt, only a comparatively small portion of its heat may be usefully employed. The chief loss is at the chimney, which is a rough and ready way of inducing the air to flow into the furnace with sufficient velocity to cause the fuel to burn, but it is an exceedingly wasteful one and will some day undoubtedly be superseded by a more scientific and economical apparatus. One pound of fairly good coal can be made to evaporate 14 to 15 pounds of water, but in some of the best boilers only 8 to 10 pounds of water per pound of such coal are evaporated in practice, with every care taken, showing conclusively that the efficiency of the boiler is less than 0.7 from this point of view.

Loss may also take place at the furnace from the following causes: (a) Bad stoking, whereby fuel is lost by falling through the bars only partly consumed and is thrown away with the ashes; this generally takes place with good fuel, owing to its friability, but may in some cases be due to carelessness in laying the fire bars; too much cannot be said of bad stoking, as from this cause alone the best designed and constructed boiler may prove most inefficient. (b) Want of air, whereby the fuel is not wholly consumed, but part of it passes off through the chimney as carbonic oxide, part in the form of smoke, part is deposited as soot in the tubes and part is burnt in the smoke-box, if there should be one. This is sometimes due to bad design and want of proper means of regulating the supply of air, but is more frequently due to bad stoking and carelessness on the part of the fireman in using the means provided. (c) Excess of air, whereby some of the heat is employed in raising the temperature of the superfluous air and thereby doing no good; this also is generally caused by bad stoking, the bars being uncovered in parts of the grate and so admitting a too large inflow of air. (d) Radiation through the mouth of the furnace when the door is open for firing and radiation through openings for other purposes; this, of course, cannot be avoided, except with mechanical stokers, but should be comparatively small; the first three sources are avoidable, and with ordinary care the loss from them should be very small as compared with the chief loss at the chimney.

To obtain an efficient draft in a chimney the temperature at its base should be about 600° Fahr., the heat of a furnace having a natural draft is usually about 2,400° Fahr., and if the heat at the exit from the boiler to obtain the necessary draft is 600° it follows that 25 percent of the total heat of combustion is wasted owing to this; if instead of a chimney, a draft were produced artificially, say, by means of a blowing engine or fan, a very considerable portion would be saved.

The usual fuels used are coal of various descriptions and qualities, wood where it is plentiful and coal is scarce. Mineral oil and creosote waste, as well as petroleum waste, can be burnt quite safely and readily in the furnace of a boiler by means of special apparatus. Of coals, there are several different kinds and many more qualities: (1) Anthracite, consisting almost entirely of free carbon, generally jet black in appearance, but sometimes greyish like black lead, has a specific gravity of about 1.5, sometimes as high as 1.9; it burns without emitting flame or smoke, but requires a strong draft to burn at all; it is capable of evaporating (theoretically) nearly 16 times its weight of water, but to obtain good results from it careful stoking is necessary, as when suddenly exposed to heat it is very friable, breaks up into small pieces and falls through the bar spaces if disturbed much, as it does not cake; the fires should be worked light when using it and the coal carefully spread. The heat is very intense and local, so that furnaces intended to burn it should be high in the crowns and protected at the sides by bricks or fire clay, or else have no air spaces down the sides. (2) Dry bituminous coal contains from 70 to 80 percent of carbon and about 15 percent of volatile matter; its specific gravity is from 1.3 to 1.45. It burns easily and swells considerably while being converted into coke; the harder kinds do not burn so readily, nor do the pieces stick together so easily when burning and they are generally better adapted for use in boilers. (3) Bituminous caking coal containing 50 to 60 percent of carbon is generally of about the same specific gravity as the dry bituminous; it contains, however, as much as 30 percent of volatile matter and consequently develops hydrocarbon gases; it burns with a long flame and sticks together in caking, so as to lose all trace of the original form of the pieces, and it requires special means to prevent heavy smoke. (4) Lignite, or brown coal, is of later formation than the other coals, and in some instances approaches to a peaty nature; it contains, however, when good, 56 to 76 percent of carbon and has a specific gravity of 1.20 to 1.35; it also contains large quantities of oxygen and a small quantity of hydrogen. The commoner kinds of lignite are poor and contain as little as 25 percent of carbon and therefore are not suitable for steaming purposes.

Where coal cannot be easily obtained wood is generally used for fuel, and the furnace must therefore be specially constructed to burn it; it consists on the average, when dry, of about 50 percent of carbon, 41 of oxygen and 6 of hydrogen. The value of a fuel is determined by its chemical composition; all fuels contain more or less of carbon, must also have hydrogen and oxygen in various proportions and some small quantities of nitrogen, sulphur, etc. These substances are usually designated by their chemical symbols—that is, by the initial letter of the name; they combine in certain fixed quantities, called their chemical equivalents, thus:

Carbon,	symbol	C,	chemical	equivalent	12.
Hydrogen,	"	H,	"	"	1.
Oxygen,	"	O,	"	"	16.
Nitrogen,	"	N,	"	"	14.
Sulphur,	"	S,	"	"	32.

A pound of carbon is capable of developing during combustion a certain quantity of heat called the total heat of combustion, and is measured by units of heat; the British standard unit of heat is defined as that quantity of heat which will raise one pound of pure water one degree Fahrenheit in temperature. The total heat of combustion of one pound of hydrogen is measured in the same way, and it is also found that the total heat of combustion of any compound of carbon and hydrogen is the sum of the quantities of heat which the hydrogen and carbon contained in it would produce if burnt separately.

If a fuel contains oxygen as well as hydrogen, it is known that 8 parts by weight of the former unite with one of the latter to form water, which exists as such in the fuel and does not add to the total heat of combustion. If there is, however, an excess of hydrogen beyond what is required to form with the oxygen the water, the remaining hydrogen does add to the total heat of combustion and may be reckoned in estimating its value. Hydrogen gas requires 8 pounds of oxygen and consequently 36 pounds of air to consume it; its total heat of combustion is 62,032 units of heat, and therefore it can evaporate 64 pounds of water from and at 212 degrees. Carbon, when fully burnt, requires only 2.7 pounds of oxygen or 12 pounds of air to consume it—that is, to convert it into carbonic acid; its total heat of combustion is 14,500 units of heat and can therefore evaporate 15 pounds of water from and at 212 degrees. If, however, it is only partially burnt, or turned merely into carbonic oxide, half the quantity of air is consumed and the total heat of combustion is only 4,400 units of heat. Sulphur exists only in small quantities in good coal, and the total heat of combustion is only about 4,000 units.

From this information the following rule is reduced for the total heat of combustion for substances containing carbon, hydrogen and oxygen:

Total heat of combustion of one pound of fuel

$$= 14{,}500 \left\{ C + 4.28 \left(H - \frac{O}{8} \right) \right\} \quad (1)$$

and

Theoretical evaporative power of one pound of fuel

$$= 15 \left\{ C + 4.28 \left(H - \frac{O}{8} \right) \right\}$$

C being the weight of carbon, H that of hydrogen and O that of oxygen, all expressed in fractions of a pound.

To burn ordinary coal 12 pounds of air are required on the average; to provide for the dilution of the gaseous products, so that free access is given to the air to reach the fuel, in practice 24 pounds of air are often used. At the temperature of 62 degrees the volumne of one pound of air is 13.14 cubic feet, therefore to consume one pound of coal 315 cubic feet of air are necessary; if, however, the draft is very good, such as found with artificial means, 250 cubic feet would be sufficient.

The quantity of coal burnt on a square foot of grate depends partly on its nature, but principally on the draft; bituminous coal burns much more freely than anthracite, and some of the softer kinds consume very rapidly. All coal burns much more rapidly with a strong draft, as might be supposed, and for that reason when only a small boiler can be fitted to supply steam, artificial draft is necessary. There are several general methods of causing an artificial draft, viz.: the steam blast, by which the products of combustion are ejected from the chimney in the same way that the exhaust steam from a locomotive produces a draft; by an air blast delivered under the fires, with a closed ash-pit, by a fan placed near the base of the chimney, which draws from the smoke-box and delivers into the stack. This latter is known as the induced draft system.

A grate of ordinary length, when the draft is good, should not be supplied with more than 15 pounds of coal per square foot of grate, to obtain complete combustion, and on a short grate, say 1.3 to 1.5, the diameter of the furnace in length 20 pounds of coal may, however, be burnt economically; with moderate forced draft 20 to 30 pounds can be readily burnt, and with good air pressure, either forced or induced and with short grates and good stoking, even as much as 60 pounds can be consumed per square foot of grate. A locomotive with a draft produced by the exhaust steam can burn 65 pounds of coal, and the modern express engine burns as much as 80 pounds per square foot of grate. The natural draft, or that obtained by means of a chimney, is very much influenced by its transverse section and by the height or distance of its top from the level of the fire-bars. The draft is due to the difference in density of the column of gas in it from that of the surrounding atmosphere; the density depends on the temperature of the gases at the chimney base, and for this reason a good draft cannot be obtained without a comparatively high temperature.

The heat of the gases from the furnace is to be absorbed by the surfaces with which they come in contact on their passage to the chimney, and the efficiency of this part of the boiler depends on the capability of those surfaces to readily take up the heat on the material to transmit it by conduction to the inner surface, or that with which the water is in contact, and on that inner surface being in such a condition as to give up the heat to the water. The internal efficiency of the boiler depends on convection or circulation of the water in the boiler, whereby fresh portions are successively brought in contact with the hot surfaces; the importance of this latter factor was seldom appreciated in estimating the efficiency of a boiler, although now engineers give it first consideration. When the furnace is internal—that is, when it forms a part of the boiler proper and is surrounded by water—a large proportion of the total heat of combustion is absorbed by it, partly by direct contact with the hot fuel, at the sides, and partly by radiation from the glowing surface of the incandescent fuel. The furnace also absorbs heat from the hot gases passing along its surfaces.

The combustion of the fuel is not always completed in the furnace of the boiler, as the gases distilled from it during the process escape to the chamber beyond the furnace before sufficient air has been supplied, and also it sometimes happens that the temperature above the fuel is not sufficiently high to cause ignition. The carbon often unites in the furnace with only sufficient oxygen to form carbonic oxide, and this flows into the combustion chamber; if there is a further supply of air to be found there, another portion of oxygen is taken up and carbonic acid gas is formed; that is what usually takes place with bituminous coal, and unless this second supply of air is provided, the combustion of a large portion of the fuel is not completed in the boiler. If the fire is completely covered with green—that is, fresh—fuel, the part next the hot surfaces parts with its volatile elements, which rise and become cooled in so doing, so that when they come in contact with the oxygen of the air the temperature is not high enough to cause them to unite chemically—that is, to ignite, and consequently they merely mix mechanically and flow on until they pass out of the mouth of the chimney and appear as smoke. When, however, by careful stoking and regulating the supply of air so that combustion is completed in the combustion chamber, the evaporative power of that part of the boiler is high, and, with the furnace, is the most valuable part of the boiler for transmitting heat to the water. The superior evaporative power of the furnace is due in great measure to the cleanliness of the surface exposed to heat; there are no deposits of soot or ash on it, and the smallest possible amount of oxide; the combustion chamber is also generally in the same condition. The roughness of the surface exposed probably increases its power of receiving heat, not so much from any abstract virtue in that state as from the actual surface being greater than if smooth. Very much depends on the condition of the inside surface exposed to the water; if it is quite clean and smooth, it is not so efficient as slightly dirty and rough, the best condition being roughness and freedom from coating of bad conductors. If a metallic surface is smooth and clean evaporation from it is slow and intermittent, because on it is formed a film of steam, which is a bad conductor, and this will only disperse when its buoyancy overcomes the attraction; when the attraction is overcome the steam rises suddenly en masse, the surrounding water then flows into its place, when a film is again formed or bubbles accumulate as before. If on the other hand the surface be rough, the film is broken up by numerous points on the surface, which serve as accumulators and starting points for myriads of small bubbles; these are formed quickly, rise freely and continuously, giving a rapid and steady supply of steam. It is for this reason that many boilers prime—that is, work with violent ebullition—when quite new. The tubes of a boiler represent the greater portion of the total heating surface, and it is to this part that great attention is required both in designing and working a boiler. Much stress is sometimes laid on certain experiments which show the relative evaporative power of certain portions of the tubes to prove thereby that the final foot or two feet of tube is practically useless in every boiler; it is not very surprising to find that the first foot of tube has a high evaporative power, and that the power decreases rapidly the further removed the portion is from the furnace or combustion chamber. Considering that the temperature of the gas on entering the tube is 2,000° to 2,400°, and on leaving it should be not more than 600°, while the temperature of the water surrounding the tube is very nearly the same (386° Fahr.) at every part, the transmission of heat should be very much more at the entering end than at the other; moreover, the end nearest the chimney is more liable to get dirty from deposits of soot, etc., and so to fall off rapidly in efficiency. But in continuous practice it was not found that there was such a large difference in the value of the two ends of the tubes, because the end at which there is the rapid evaporation soon became covered with scale and its efficiency thereby reduced; the temperature was then not so much reduced after passing through the first portion, and for this reason the latter portion was found to have a higher efficiency than before. The size of a tube has also some influence on its efficiency, for whereas the surface increases as the diameter, the contents increase as the square of the diameter; if a tube then of 4 inches diameter be substituted for two of 2 inches diameter the surface is the same, while the cubic capacity is doubled; if the rate of flow be the same in both cases the 4-inch tube will pass twice the quantity of gas through it that flows through the two 2-inch ones and have only the same surface to absorb and transmit the heat. If the quantity flowing through the tubes be the same in both cases the 4-inch tube is still at a disadvantage, inasmuch as the mean distance of the gas from its surface is greater than that of the 2-inch ones; also the velocity through the small tubes will, in the latter case, be double that in the 4-inch one and will therefore cause a brisker circulation of the hot gas, and the liability of soot and ash deposit is considerably reduced. Hence tubes of smaller diameter are used with advantage with forced draft, for the same amount of evaporation is effected with smaller amounts of surface. If a boiler has just enough surface to absorb heat from the gases, so that the temperature at the chimney base is only such as is sufficient to produce the required draft, then the heating surface is effective; any surface added to this is superfluous and in very many cases does positive harm.

The probable evaporative power of a boiler may be found approximately by the formula: Let e be the theoretical evaporative power of the fuel; F the weight of coal burned on the grate in pounds per hour and K the total heating surface in square feet; then

Pounds of water evaporated per pound of fuel burnt

$$= 1.833\left(\frac{K}{2K+F}\right)e.$$

Care of a Steam Boiler.

A boiler needs washing at least once every month, and more often if the feed water is bad. Do not allow mud or scale to accumulate in the boiler, and do not allow oil or grease to enter the boiler; these foreign substances may cause overheating and burning of plates and result in a bag, rupture or violent explosion. A solution of soda ash or a small quantity of kerosene fed continuously into the boiler is often beneficial in preventing or softening scale. If kerosene is used, great care must be exercised to see that it is entirely gotten rid of by allowing a draft to blow through the boiler before bringing a naked light to the boiler or allowing anyone to enter the boiler, as an explosion may ensue or the fumes may overcome the person entering.—*The Fidelity and Casualty Company of New York.*

THE POWER OF A LOCOMOTIVE BOILER.

BY C. HUGH SUMNER, WH. EX., A. M. INST. C. E.

During the last decade a revolution in opinion has taken place in England with regard to the size of locomotive boilers. It has been more and more recognized that the power of a locomotive is limited by the amount of steam which the boiler can supply, and in this respect there is a tendency to fall into line with American practice where large boilers are the rule. In this article the writer proposes to trace the relation between the size of the boiler and the power developed by the locomotive.

Before proceeding any further, it may be as well to review briefly the conditions under which the locomotive boiler has to work. In the first place, owing to restrictions of space and weight, it must be an enormoursly rapid steam generator. This necessitates a large area of heating surface compared with the amount of water carried in the boiler. Secondly, owing to the small space available for the grate, a high rate of combustion must be maintained. This latter condition is rendered possible by the action of the blast-pipe, and also by the very efficient circulation promoted by the vibration of the engine. It is impossible to get the same rate of combustion on land boilers as on locomotives, owing to the water being unable to take up the heat sufficiently quickly, the result being unequal expansion, local overheating, and consequent leakage. It is this very efficient circulation which, by enabling the water to take up the bulk of the heat offered, maintains the efficiency of the locomotive boiler at a level vieing with the best land and marine boilers in spite of the distinctly unfavorable conditions for economical fuel consumption.

In laying out the design of a boiler it will be found the leading dimensions are governed almost entirely by the wheel arrangement of the engine, and, in the case of large boilers, by the limits imposed by the loading gage. The length of the boiler must be considered in conjunction with the wheel-base. The front tube-plate is generally level with the back of the cylinders, and the length of the barrel is fixed, in the case of four or six coupled inside cylinder engines, by the amount of room required for the cranks. This generally necessitates the fire-box being sloped up at the back to clear the trailing axle, although, in the case of small engines with a short fire-box, it is sometimes feasible to drop the fire-box between the axles. The height of the boiler will be governed by the relation of its diameter to the size of the driving-wheels, although sometimes a boiler may have to be raised in order to get sufficient depth for the fire-box when the latter is carried over one of the axles, and the diameter of the wheels is large. The diameter of the boiler is generally as small as is cosistent with obtaining sufficient room for the tubes, the number and diameter of which will depend on the heating surface required.

The power developed by a locomotive boiler is limited chiefly by the size of the grate, and by the maximum rate of coal consumption. As regards the latter point, through the kindness of Mr. S. D. Holden, the locomotive superintendent of the Great Eastern Railway, the writer was recently afforded opportunities of noticing the rate of firing on express trains, and as a result of his observations he is enabled to state that the rate of coal consumption reached as high a value as 150 pounds per square foot per hour for a period of 10 minutes, the average on a non-stop run of 90 minutes' duration being 90 pounds per square foot per hour. The size of the grate was 21.6 square feet, and the load behind the tender was 300 tons, the average booked speed being 45 miles per hour.

The amount of water required by a locomotive is usually stated as being from 22 to 30 pounds per indicated horsepower-hour, the rather excessive amount being generally credited to the very wet steam which the locomotive boiler is accused of supplying, some authorities stating that the dryness fraction is as low as 60 percent. In order to obtain some light on this debatable point, the writer recently calculated the steam consumption from a set of indicator cards taken from an express engine, and, assuming different dryness fractions, plotted the cards on an entropy chart until the horsepower of the entropy diagram agreed with the horsepower of the actual card. As a result he found that the average wetness of the steam during admission did not exceed 10 percent, even when working heavily with the regulator wide open. The steam consumption measured from the indicator cards varied between 16 and 18 pounds per indicated horsepower-hour, the higher figure being for a cut-off of 25 percent, hence the water consumption to be debited to the cylinders would be about 19 pounds per indicated horsepower-hour. Nevertheless it is a fact that the water consumption, as measured from the tender, is from 22 to 25 pounds per indicated horsepower-hour, and hence it is necessary to see what becomes of the remainder. Some of the steam is used by the injectors and also by the brake, and a certain amount is wasted at the safety-valves, and there is also a loss of water at the injector overflow. Reckoning that the steam used by the injector is 1 pound for every 10 pounds of water fed into the boiler, which means 2 pounds per indicated horsepower-hour accounted for by the injector, and putting the supply to brakes, waste at safety valves, and injector overflow, at 10 percent of the total, say 2½ pounds per indicated horsepower, we have:

Steam used by	cylinders per I. H. P. hour	= 19 lbs.
" "	injector per I. H. P. hour	= 2 "
" "	brakes, etc.	= 2½"
	Total	............23½

As, however, the chief demand made on the boiler while running is that of the engine, the brakes and safety valve losses only occurring, as a rule, when steam is shut off, we shall be justified in assuming that the average call for steam is 21 pounds per indicated horsepower.

The evaporative power of the boiler is generally given in pounds of water evaporated from feed temperature per square foot of heating surface per hour, and depends on the rate of coal consumption and the ratio of heating surface to grate area. This ratio varies between 60 and 100, the average being from 75 to 80. With a ratio of less than 60, the flue area will probably be so much reduced as to require a sharp blast, as was exemplified in the oft-quoted experiments on the French boiler, in which it was shown that for the same coal consumption the evaporation was approximately the same with half the tubes plugged up as with all the tubes open. It does not generally seem to have been noticed, however, that from 50 to 80 percent more draft was required to maintain the same coal consumption when half the tubes were plugged up. As regards the upper limit of the ratio, viz., 100, if this is obtained by crowding the tubes together or by making them of abnormal length, the advantage will be more apparent than real. Crowding the tubes together obstructs the circulation of the water and abnormal length will result in increased frictional resistance for the hot gases, and in addition the last foot or two of length is not of much heating value, owing to the reduced temperature of the gases. In the following investigation the ratio of heating surface to grate area will be taken as 75; that is to say, the heating surface is 75 times the grate area.

Before proceeding any further, it will be as well to calculate the amount of water evaporated per pound of coal, and to do this we will assume that the steam pressure is 170 pounds gage, the dryness fraction 0.9, the feed temperature 60 degrees F., and that the boiler efficiency is 70 percent, with coal having a calorific value of 14,000 British thermal units.

From the steam tables the sensible and total heats of steam at 170 pounds gage, when evaporated from water at 60 degrees F., are 348 and 1136.3 British thermal units, respectively, so that the heat required to evaporate 1 pound of steam of 0.9 dryness,

$$= \frac{1136.3 \times .9 + 288}{10} = 1051.5 \text{ B. T. U.}$$

and the water evaporated by one pound of coal

$$= \frac{14{,}000 \times .7}{1051.5} = 9.3 \text{ pounds.}$$

If C be the coal consumption per square foot of grate per hour, then the evaporation per square foot of the heating surface per hour

$$= E = \frac{9.3 \times C}{75} = 0.124 \times C \text{ pounds.}$$

As the power exerted by a locomotive is generally given as so many pounds tractive force at a certain speed, it will be convenient to reduce the boiler power to its equivalent tractive force. To do this, it will be necessary to assume that the rate of evaporation is constant, although, strictly speaking, this is not the case, as the power of the boiler increases with the blast of the engine.

Let T be the cylinder tractive force in pounds.
I.H.P. be the cylinder indicated H.P.
V be the velocity in miles per hour.

$$\text{Then } T = \frac{\text{I.H.P.} \times 33{,}000 \times 60}{5280 \times V} = 375 \frac{\text{I.H.P.}}{V} \quad . \quad . \quad (1)$$

If the grate area be denoted by G, we have, taking the steam consumption at 21 pounds per I. H. P.

$$\frac{G \times C \times 9.3}{21} = \text{I.H.P.} \quad . \quad . \quad . \quad . \quad (2)$$

substituting for I.H.P. in (1)

$$T = \frac{375 \times G \times C \times 9.3}{21\,V} = 166 \frac{G \times C}{V} \quad . \quad . \quad (3)$$

If H represents the heating surface, then (2) becomes

$$\frac{E \times H}{21} = \text{I.H.P.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

E being as before the evaporation per square foot of heating surface per hour. Substituting (4) in (1) we get

$$T = \frac{375 \times E \times H}{21 \times V}$$

$$= \frac{375 \times 0.124\, C \times H}{21 \times V}$$

$$= 2.21 \frac{C \times H}{V} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

By introducing a factor, say .85, representing the mechanical efficiency of the locomotive, and assigning a suitable value to C, we shall obtain expressions giving the available tractive force at the rails. For instance, if the maximum coal consumption be put at 120 pounds per square foot of grate per hour, then

$$T_1 = 0.85\, T$$

$$= (0.85 \times 166 \times 120) \frac{G}{V}$$

$$T_1 = 16{,}930\frac{G}{V} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$T_1 = (0.85 \times 2.21 \times 120)\frac{H}{V}$$

$$= 225\frac{H}{V} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where T_1 is the available boiler tractive force.

In order to find the load that can be hauled, divide the tractive force as given above by the resistance per ton at the required speed, and the quotient will give the gross load in tons. By inverting V and T_1 and putting T_1 as the total resistance of the train, we can determine the velocity that will be acquired. At low velocities the tractive force as found above may exceed the tractive force of the engine as found in the usual way; of course the lower value should be taken.

As a numerical example let us take the case of an express engine working a train at a speed of 60 miles per hour on the level, and suppose that the engine has a grate area of 20 square feet, and that the weight of the engine and tender is 90 tons. Then, taking Eqn. (6), we have as the total tractive force

$$T = 16{,}930\frac{G}{V} = \frac{16{,}930 \times 20}{60} = 5{,}643 \text{ pounds.}$$

At a speed of 60 miles per hour the resistance per ton is about 16 pounds.

$$\text{Hence the gross load} = \frac{5{,}643}{16} = 353 \text{ tons,}$$

and the net load behind the tender will be $353 - 90 = 263$ tons approximately, equal to twenty six-wheeled vehicles. Such a load would probably be as much as an engine having 18-inch by 26-inch cylinders could manage, especially if a side wind was blowing.

The chief value of the big boiler lies in the fact that it carries so large a bulk of hot water that, should the steam pressure show a tendency to fall when nearing the top of a long bank, the feed can be shut off, thus temporarily increasing the boiler power by some 25 percent, owing to the fact that the latent heat of evaporation only has to be supplied. With the modern big boiler some 3 or 4 miles can be run with the feed shut off without letting the water level drop dangerously low.

For a similar reason it is advisable not to sacrifice water space to heating surface in engines which have to stop and start frequently. Such engines generally need to accelerate the speed rapidly, and it is of great use to be able to hold the injector off until speed has been attained, and the boiler can be filled up as soon as steam is shut off, thus preventing the safety valves from lifting.

In conclusion, the writer would emphasize the fact that such calculations as the above must not be regarded as rigidly correct, as the conditions under which the locomotive works are continually changing. At the same time the numerical constants inserted in the formulæ given above are such as to give loads which are within the power of an engine under distinctly adverse circumstances.—*The Engineering Review.*

MAIN OFFICE OF THE SCULLY STEEL AND IRON COMPANY.

Boiler inspection, to be of value, must be thorough, systematic and intelligently performed by a competent and reliable inspector.

NEW WAREHOUSES OF THE SCULLY STEEL AND IRON COMPANY.

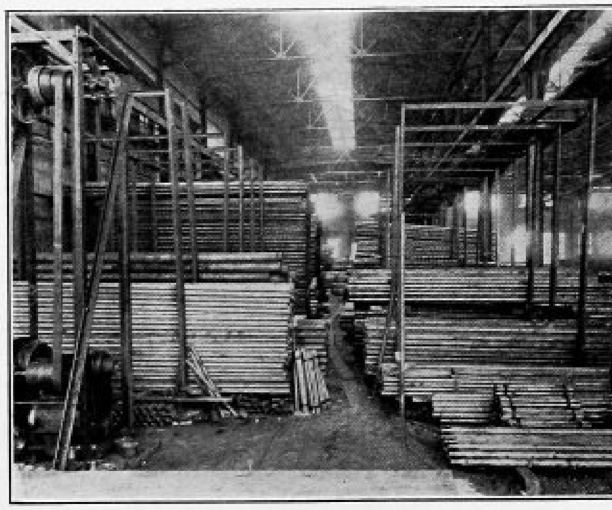
The Scully Steel & Iron Company, Chicago, have recently built a new plant which has a frontage of 289 feet on the south branch of the Chicago River. An excavated channel, or slip, extends 1,700 feet north from the river along the warehouse property, including a vacant portion on which the buildings may be extended to provide for expansion. This channel is of sufficient depth to accommodate any boats which can enter the Chicago River. Therefore, large cargoes of iron and steel can be shipped directly by water to the company's plant. This oftentimes results in considerable saving in freight rates, as the Eastern railroads favor this traffic by operating their own steamship lines and making lower rates by water than by the all-rail routes.

The most important feature of this new plant is the main warehouse, in which are carried the stocks of structural material, tubes, bars, plates and other rolled products. Electric cranes, so situated as to serve every portion of the warehouse, are used for handling this material. The stock, as shown in the illustrations, is piled flat.

The warehouse is 240 feet by 639 feet. There is a river dock at one end, and railroad tracks extend inside the building on each side. The building is divided into twelve bays, three of which are 75 feet wide, three 50 feet and six 40 feet. The 75-foot bays are used for the storage of beams, channels and other long, heavy structural material which usually runs in 60-foot lengths. The smaller bays are used for shorter material and miscellaneous shapes.

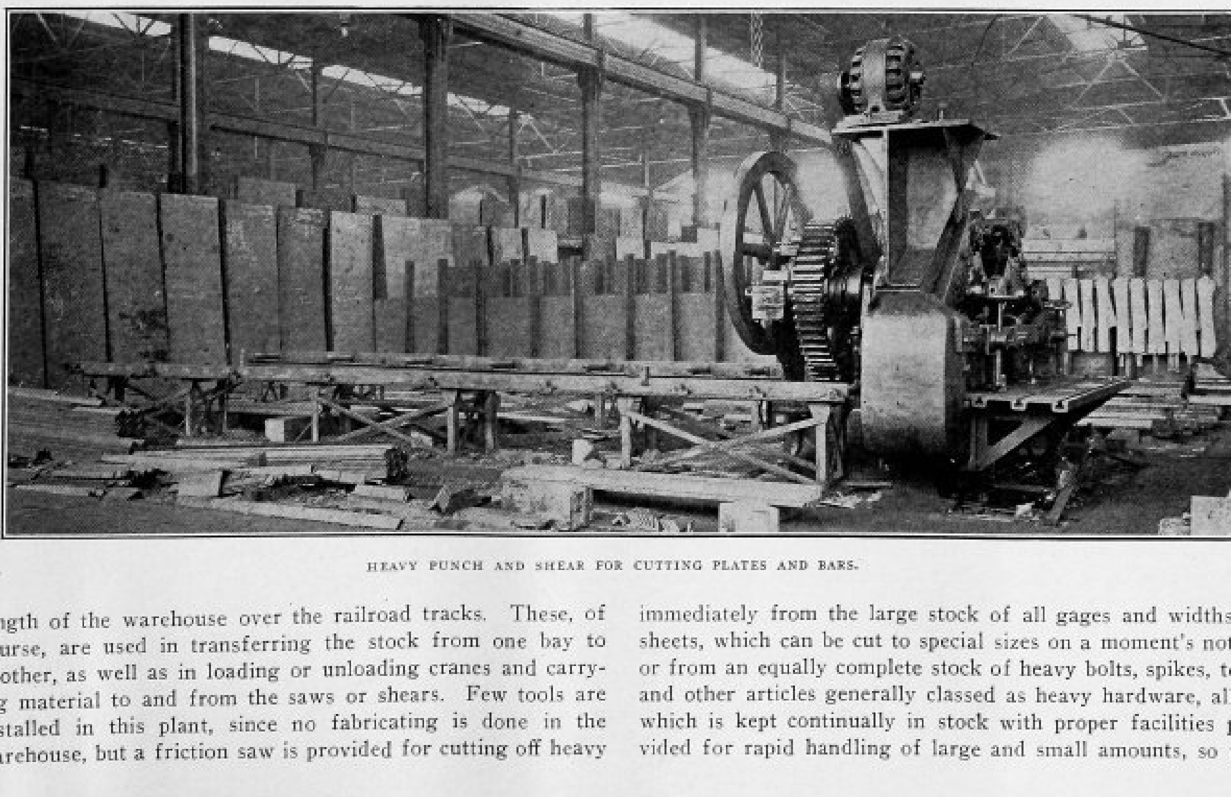
The material as received at the plant is unloaded from the cars or boats by means of an electric crane running over each of the twelve bays. These cranes deposit the material in its proper place, so that material of any size or section can be secured at a moment's notice. The heavy structural steel in the three 75-foot bays is handled by three Cleveland cranes of 10 tons capacity. The smaller bays are served by Whiting cranes of 5 tons capacity. Two cranes run at right angles to those serving the individual bays, and can be operated for the entire length of the warehouse over the railroad tracks. These, of course, are used in transferring the stock from one bay to another, as well as in loading or unloading cranes and carrying material to and from the saws or shears. Few tools are installed in this plant, since no fabricating is done in the warehouse, but a friction saw is provided for cutting off heavy stock, as well as a cold saw, a heavy punch and shears for cutting angles, bars, plates and tubes.

The railroad facilities include three sidings for loading and unloading cars, two of which, one on each side, extend the full length of the plant, while the third runs through the middle of one of the warehouses with platforms on each side for handling material in or out of the cars.



BOILER-TUBE DEPARTMENT.

For local service, or what is known as the store trade, every effort is made to handle the stock promptly and economically. There is room to stack all the finished iron and steel products in a systematic manner, so that they can be handled quickly with the best economy in labor. Hand trucks are used only in the sheet and hardware warehouses. A shear, operated by electricity, is located conveniently on the sheet floor. Whenever a rush order is received from any of the large manufacturing plants in and about Chicago, the order can be filled immediately from the large stock of all gages and widths of sheets, which can be cut to special sizes on a moment's notice, or from an equally complete stock of heavy bolts, spikes, tools and other articles generally classed as heavy hardware, all of which is kept continually in stock with proper facilities provided for rapid handling of large and small amounts, so that



HEAVY PUNCH AND SHEAR FOR CUTTING PLATES AND BARS.

an order can be loaded upon a dray within a very few minutes after having been received over the telephone.

One of our illustrations shows a portion of the large office which is found necessary to carry on this immense business. The main office is a single room, 100 by 150 feet, divided into departments by low steel partitions. The desks, filing cases and other fittings, including doors and door casings, are all of steel. All the exposed steel surfaces are enameled with a mahogany finish, and the effect is so realistic that it might easily be taken for real mahogany. The columns in the office are covered with ornamental bronze steel with the same finish. The officers of the company have private offices on either side of the main office; but emphasis is laid on the fact that the doors of these offices are always kept open, especially to employees.

PLATE STORAGE.

Ventilation in the main office is secured by means of two large ventilating fans at either end of the overhead skylight. One of these blows the air in and the other blows it out. The heated air under the skylight is thus carried out and a constant supply of fresh air is drawn in.

Accessories to the plant include a restaurant and gymnasium. In the restaurant the same food is served to all the company's office employees, numbering about 100, but the price is graded, running all the way from 10 cents for an office boy to 50 cents for a department manager. The company loses a little money in conducting the restaurant service, but every one gets a square meal, and the service is appreciated, as there are no outside restaurants worthy of patronage in that part of the city.

The American Boiler Manufacturers' Association will hold its twenty-second annual convention in Chicago October 10, 11, 12 and 13. The headquarters of the association will be at the Auditorium Annex.

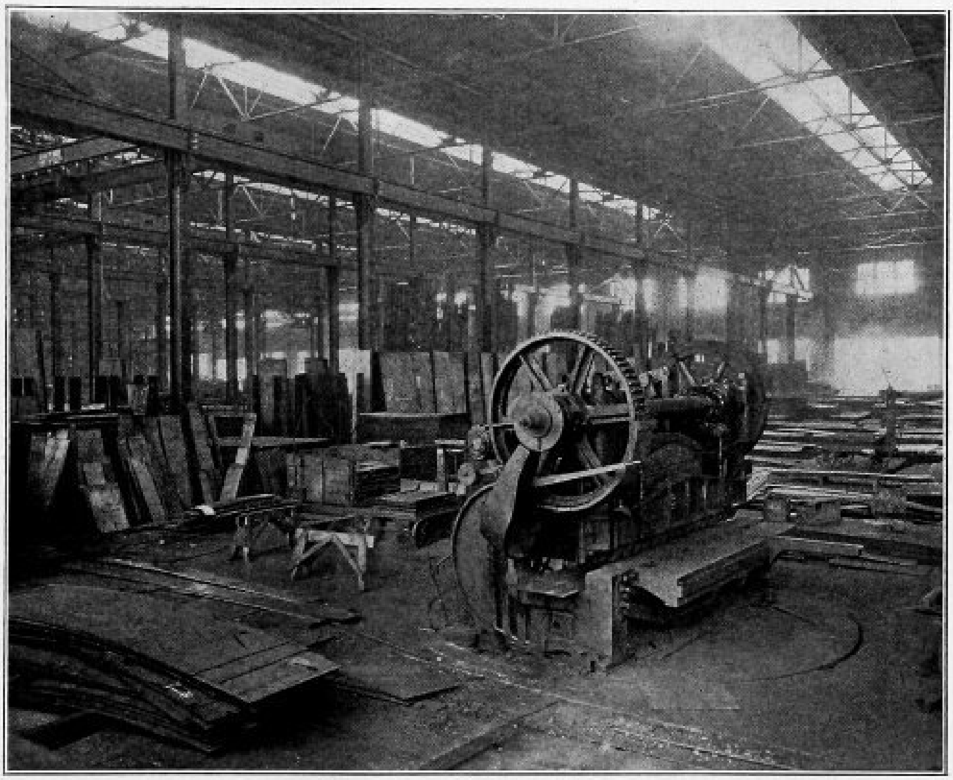
LIFE OF FIREBOXES AND TUBES.

In his report on improvements in locomotive boilers before the International Railway Congress, H. H. Vaughan, assistant to the vice-president of the Canadian Pacific, had the following to say concerning the life of fireboxes and tubes on American locomotives:

LIFE OF FIREBOXES.

The life obtained from steel fireboxes varies considerably with the quality of the water used and with the type of firebox. No reliable information is obtainable with reference to the influence of the quality of steel on the life of the firebox with the exception that one administration reports steel having from 0.10 to 0.18 percent carbon has been found to give better results than steel having from 0.18 to 0.25 percent, while several report that a special brand of acid steel having exceptionally low phosphorus and sulphur has been found preferable. Some administrations with locomotives of an older type in which the firebox is deep and placed between the frames and where water is of good quality report the life of fireboxes as high as 20 years and over, but the general experience with modern engines using 180 to 200 pounds' boiler pressure is that the life varies from two to four years in bad water districts, and up to ten years and over where water is good. The exact life of fireboxes is difficult to determine from the fact that the various sheets composing it do not last the same length of time. Where the nature of the scale is such that the sheets become easily overheated and the service is severe, side sheets in engines of the wide firebox type are occasionally replaced in from one to one and a half years, while crown sheets which do not deteriorate so quickly give considerably longer service. Thus one administration reports that side sheets are being renewed in from one to three years, while crown and flue sheets average five years' life.

It is difficult to present any correct figures on account of the great variation in the conditions. The figures given above are fairly representative of the replies received from a number of administrations. The Buenos Ayres & Rosario Railway, which uses both copper and steel fireboxes, states that with copper the life of the firebox has been from 10 to 12 years and with steel about four years. This would indicate a considerably longer life for copper fireboxes than for those made of steel, but the copper firebox has been found impracticable in American service on account of the rapid erosion caused by the sparks, due to the high rates of combustion at which engines are frequently worked. It should be borne in mind in connection with the life of fireboxes, that in American practice the miles run per locomotive per annum are exceedingly high, 30,000 to 35,000 miles frequently being obtained, while individual engines in passenger service have been run from 6,000 to 7,500 miles per month. Measuring the life of fireboxes, therefore, in terms of years does not represent entirely the service obtained, unless the miles run per month or per annum are taken into account, and when this is done the service obtained from steel fireboxes becomes satisfactory. The reason for the rapid deterioration of the side sheets in wide firebox engines in service where the water is of a bad quality is not entirely clear. It has, however, recently been ascribed to the inclination of the firebox sheets towards each other at the top so that the bubbles of steam formed next the sheet are not wiped off by the ascending streams of steam bubbles from other portions of the sheet, as is the case with fireboxes of a narrow type placed between or on top of the frames. Some boilers have recently been constructed in which the width of the firebox is reduced in order to allow of the inclination of the firebox sheet outwards towards the top so as to obtain this action. Whether from this cause or not there is little doubt that overheating of side sheets occurs and that the reason is on account of insufficient circulation. Some recent experiments have indicated that an improvement may be obtained by arranging for a greater depth of water in the sides of the firebox below the surface of the grates, and this would also confirm the theory that defective circulation is a reason for the short life frequently obtained from side sheets on boilers of the wide firebox type.



VIEW IN THE LARGE WAREHOUSE OF THE SCULLY STEEL AND IRON COMPANY.

LIFE OF TUBES.

The life of tubes varies largely with the quality of the water. It is common practice to safe-end or weld additional portions on to the body of the tube from four to ten times where the water is such that no pitting of the body of the tube occurs. The length of time required before the tube is removed on account of the end being so damaged by rolling and beading that it cannot be maintained in a sufficiently tight condition for proper service varies according to the water conditions, and type of engine, from five to six months up to three years and over. On one railway tubes are removed for safe-ending after 40 to 60 thousand miles in freight service and 75,000 to 110,000 miles in passenger service. On another they are removed in bad water districts after five to six months, and in relatively good water districts after 10 to 12 months. The shortest life of the body of the tube reported is from two to three years, while some administrations report tubes lasting as long as 15 years and over. Where no pitting occurs and the water is of an average quality, the life of the body of the tube will average from 8 to 12 years before it is scrapped on account of insufficient strength. The Buenos Ayres & Rosario Railway, which uses both brass and iron tubes, reports brass tubes as lasting from 10 to 12 years, while iron tubes are scrapped after four years on account of pitting. This evidently is caused by the quality of the water, and there would not appear to be a very great difference between the life of the brass and iron tubes where the water is not of such a quality that the body of the tube is attacked.

INDEXING SYSTEM FOR BOILER AND PLATE METAL SHOPS COVERING BLUE PRINTS, TRACINGS AND PATTERNS—IV.

BY EDWIN E. ROHRER.

PATTERN-FOUNDRY SYSTEM.

The details as laid down so far in these articles were intended for the boiler maker's interest, or in fact for any firm not manufacturing castings but who were designing same, From this you readily see that the system, as has been explained, would work equally as well for a foundry that made a specialty of certain machinery and had their own patterns. However, to simplify the matter we will refer to the previous articles as the boiler maker's, and this final part as the foundry's.

Attention is called to the fact that the system, as has been explained, deals only with the pattern numbers, and that it makes no difference to the boiler maker how the foundry keeps track of the patterns, just so long as they can find them and do not make extra charges for patterns they should have.

Did you ever know of a pattern storage house with, say, ten thousand patterns kept in same, and only about one or two men around the place who could go out and find a pattern readily, simply because they had handled the patterns so often? Such a place has no system at all, simply depending on one or two men to find things. The writer knows of such storage houses, and undoubtedly the reader does, too. Stop and think what these men are paid for. Often one, at least, is the head pattern maker. Does this sound right? I ask all readers not to lose sight of the fact that this is not the age when men live to be 962 years old, as did Methuselah, and there is some doubt if he would have reached this ripe old age if his head had been full of pattern storage information. Our motto is "Don't depend on man's memory for such important things as patterns, which are worth as much ten years from the time made as when first made, if properly cared for."

We feel that we have come to the last cross roads in this series of articles and will leave the reader to judge for himself. We, however, will travel on and lay down details that will help you to follow the road that improves the further you go on it.

The pattern storage should be divided into sections, and the sections into shelves. These sections may be of any convenient size and the shelves placed so as to accommodate the largest possible number of patterns. The divisions will depend entirely upon the size of the patterns and style of work done.

The sections which are divided into shelves should not be too large, so that you can reach any pattern in them from one side or the other. The patterns may be stored in the shelves according to size only. It will make no difference if the patterns in a certain shelf are all the same style or not, as will be shown later on. It is well to arrange them according to size, however, as they can be stored away to better advantage. Always keep the large patterns on the lower floor and close to doors if possible, as it will save time in handling them.

The head pattern maker should have a list in the pattern shop of the different sections that are not completely filled, so that he can readily tell just what section or section and shelf his new pattern will best be stored in.

The mistake that is often made by foundry management is that they can't see the importance of having a man in charge of the pattern storage. Instead, they let most any one go and look for patterns, and then, of course, there is no one to see that the pattern is returned to its place. Did you ever start out to look up a pattern that was not in its place? Well, it's the same old story, "No one knows anything about it." It's also pretty expensive to have the superintendent spend his time looking up lost patterns—this I have seen done. We advise having a man in charge of the storage.

The sections are marked with a letter and the shelves with a number. The sections, however, that are not subdivided we give two letters, as "N N" or "A A." The pattern maker must be given the pattern number by the office. When he receives his orders to make such and such patterns he should be advised at the same time whose property the finished pattern is to be. Of course, if it is the purchaser's pattern, it will not have the foundry pattern number, and if it is the property of the boiler maker and to be kept at the foundry indefinitely the boiler maker will supply the pattern number when he places the order with the foundry. Foundries doing a large percentage of work for an outside firm should have a part of their storage kept for the accommodation of these patterns.

We will now refer to the necessary material the foundry should have to keep the system in proper shape. First a card index is needed and two cabinets for the cards, the capacity depending on the size of the business. The cards should be not less than 6 x 4 inches and printed as shown in the illustration. You will note, however, only part of the printing has to do with the filing system. The other is used so as to have a complete record of the finished casting.

These cards should be purchased in two colors, say white and buff. The white cards are for the office use and the buff cards for the pattern shop, as they do not show the dirt so readily. I would advise having some cheap paper printed exactly the same as the cards and have this put up in tablet form, to be kept at the pattern shop. The above would be all the material required, except the pattern number book, as described in the September issue. This book, it is understood, would not be needed unless the foundry were using the same system as was explained for the boiler maker's interest.

Let us take an example in the form of an order sent to the foundry by the boiler maker for a door and frame per blue print O-279. Frame pattern 1011; door pattern 1012. The pattern maker receives instructions to make a new pattern, and when these are completed he marks the above pattern numbers on same and then refers to his list to see in what section he had best store them. Suppose he decides on Section G, Shelf 1. Then besides the above pattern number he also paints Section G, Shelf 1 on his pattern and it is ready to go into the foundry.

When the molders are through with it, it may be stored right in its place. The pattern maker now has an important part to do with the system before he turns his attention to another job. He at once should take his tablet with the printed card form and write up the information required thereon and have a certain place to file same. Every week or so these slips should be sent to the foundry office and copied on the cards; the buff cards then returned to the pattern shop and the second copy on the white cards, which have the complete data regarding weight, etc., to remain in the office. It is not necessary that information be copied on the pattern shop cards.

See to it that the description written on by the pattern maker is explicit. If this system is in use by the boiler maker and the foundry, a good way is to have the pattern of the boiler maker marked Patt. 1011 and the patterns of the foundry marked the initials of same as C. F. P.—1011. In this way we can tell at a glance whose property it is.

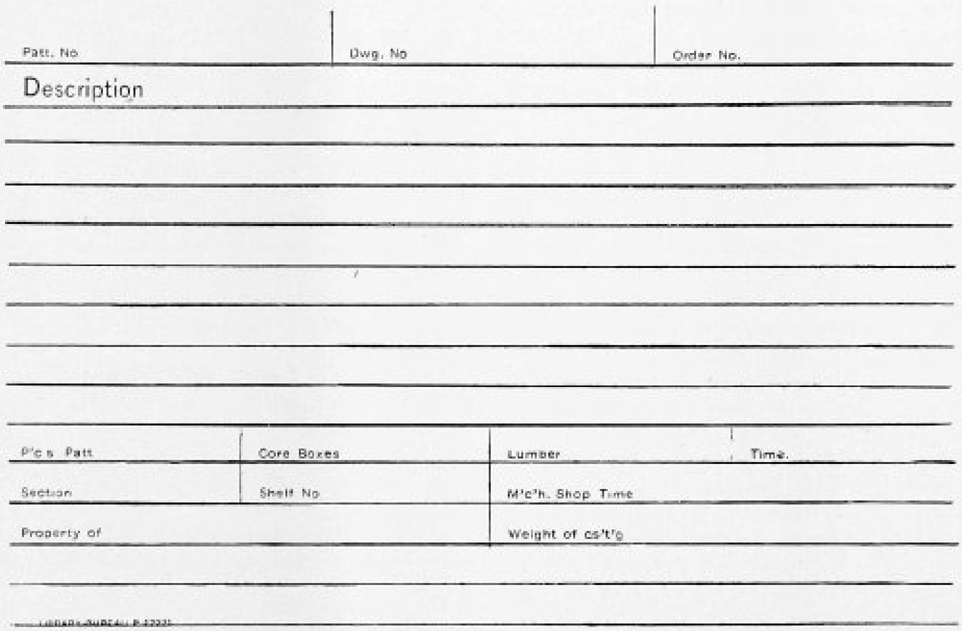
Do not allow cards to be removed from the cabinets.

Do not alter patterns unless same can be changed back to the original.

When a pattern is lagged up or stopped off in the sand, etc., there is no new pattern number marked on same, although the drawing will refer to pattern number as 476-A or 476-B, as the case may be. The pattern maker must write up a slip in the same manner as for an altered pattern, and he will mark his slip pattern No. 476-A or 476-B, etc., and on this slip will describe just how the casting was made from this pattern.

Referring to the article in the September issue near the lower right-hand corner of page 269, where it is stated, "Now, if the nozzle is to have the bolt flange a little large in diameter, and same can be changed by attaching a light strip around the outer edge, you will not require any pattern number for this." This was meant to transfer the idea that you would not require a pattern number on the pattern. You do, however, want to use the number in connection with the drawing and cards.

The writer of this series of articles will endeavor to answer any questions or explain any points that may come to the mind of interested readers who are thinking of starting a system of this kind. He can be reached through the editor of this paper.


Patt. No. Dwg. No. Order No.
Description
P'c's. Patt. Core Boxes Lumber Time.
Section Shelf No. M'c'h. Shop Time
Property of Weight of cs't'g

FAC-SIMILE OF CARD.

Tube Joints.

In watertube boilers more than in firetube boilers the question of securing the tubes in the tube plates to resist the pressure tending to pull the tube from the plate is a perplexing and sometimes serious one to solve. A certain amount of rolling will fix the tube in the plate as firmly as it ever can be by rolling alone. Any further rolling simply tends to reduce the thickness of the tube and is detrimental.

Additional holding power, however, can be obtained by flaring the tubes, or by tapering the holes, or by cutting grooves in the tube plate or roughing the plate, so that there will be something for the tube to grip besides the smooth metal. Although flaring and beading the tubes add considerably to the ultimate holding power of the tube, yet they do not always increase the slipping point of the tube, and this is the really important consideration. Once a tube begins to slip, it causes leakage and almost as much trouble as if the tube had pulled out entirely.

NOTES ON A BOILER EXPLOSION.*

BY C. J. MAGGS.

In dealing with the above subject it is not my intention to go scientifically into the subject or to propound any new theory, but it struck me that the plain facts recorded may be of some use to those in charge of steam boilers. The explosion to which I refer took place in the Essequibo River, British Guiana, at a point about 100 miles from Georgetown, in the interior, on April 9, 1907. A very unfortunate affair, as a properly certified assistant-superintendent engineer had been appointed to this station only four months before.

The boiler was in use on a launch, 60 feet long, 10 feet beam, single cylinder, high-pressure engine, the boiler single-ended marine return tube, 6 feet in length over front and back plates, 3 feet 8 inches external diameter, single plain furnace tube 4 feet 9 inches over all in length, and 22 inches internal diameter with return tubes 2 inches external diameter and 4 feet long. The boiler was formed by a single steel plate 5/16 inch thick and jointed by one longitudinal double-riveted lap seam, rivets 5/8 inch diameter, 2¼ pitch placed zigzag. The front and back plates were braced by two stays 1⅞ inches diameter, the combustion chamber was secured to the shell in the ordinary way by screwed stays. The working pressure was 100 pounds per square inch, and the fuel used was wood.

On the day of the explosion the launch left Rockstone with two boats towing alongside; in one of these one ton of gunpowder formed part of the cargo. When information was received of the accident, it was immediately surmised that a spark from the funnel must have fired the gunpowder. Three men lost their lives, the captain, engineer and fireman; fortunately there were only seven people on board on this trip. Sometimes there are as many as 50 passengers. It happened so suddenly and with such terrific violence that no coherent account could be got from the survivors.

The wreck was raised and brought to Rockstone to settle the doubt whether it was the boiler or the gunpowder. It proved to be the boiler, and the damage was clearly evident from an inspection of photographs, which were taken by

* From the Transactions of the Institute of Marine Engineers.

myself. On examining the boiler I found the interior in first-class condition; no corrosion worth mentioning was to be seen, so it was evident that the explosion was not due to wasting of the plate. As one photograph showed, the shell plate was rent from front to back, and likewise in the two circumferential joints, throwing back the shell plate outwards and downwards on the starboard side of the launch, at the same time forcing the boiler off its seat and turning it about a quarter towards the port side.

From an examination of the edge of the plate I concluded that the direct cause of this explosion was a fracture in the shell plate along the longitudinal lap seam on the port side of boiler, because the edge of the plate showed two distinct forms of fracture, the inner part clean cut and the outer ragged, which pointed at once to grooving or nicking. The plate was not wasted, the full thickness measuring up to the fractured edge, caused no doubt by the indirect straining that exists at lap joints, owing to the tendency of the internal pressure to make the boiler assume a perfectly cylindrical form, and the variations of pressure to cause the groove or crack to develop more or less rapidly.

The detection of a defect of this kind would be extremely difficult, as the size of this boiler was too small to allow any visual examination to be made. In this particular case there is a probability that in the first instance the calking tool hastened the grooving by nicking the plate. In the middle of the longitudinal fracture the groove had penetrated through the plate save 1/16 inch, gradually narrowing towards both ends, the middle of the rupture being bulged outwards. Taking the longitudinal seam as a girder supported at each end with a load evenly distributed, naturally any movement caused by internal pressure would be greatest at the center, which would account for the ruptured edge being bulged, and likewise causing it to be the first point to give way. Once that part of the shell plate had been separated, it is easy to conceive how the initial fracture was continued through the other parts of the shell by a pressure that would be insufficient to start the rent. The expansion of a volume of steam at a high pressure from a large body of water at a high temperature would force the plate forward with great force, flattening out the shell plate as shown in the photographs, causing the rupture to pass through front and back plates, showing plate, rivets and rivet holes according to the position of the line of least resistance. At the subsequent inquiry there was much contention as to the value of the hammer test and the hydraulic test, the majority leaning towards the hydraulic. I contend it is quite possible to pass a fracture of this sort, relying on the sound given out by a blow of the hammer; if the crack is not quite through it will scarcely affect the sound given out.

I have about 30 land and marine boilers under my care, and in the workshops, which we claim to be the largest in this part of the world; we undertake repairs to boilers, machinery, etc. It happened that two boilers of a well-known water-tube make belonging to an outside company were placed in our hands for repairs. Grooving was suspected in the upper or steam drum; this was discovered by the engineer-in-charge when attending to some valve at the top having felt a leak of steam blowing against his leg. The boiler was shut off, orders were placed with us to *calk* the leak, the hydraulic pump was applied to locate the spot. When full pressure was applied not a sign of leak showed itself; the engineer-in-charge then struck the plate with his hammer. Immediately a thin sheet of water escaped through the plate at the edge of the lap joint and disclosed the groove or crack; this sounds very peculiar, but it is true. This was repaired by a double-butt strap after cutting away the fractured lap edge. In the case of the second boiler (they were side by side), the same defect was found and treated in a similar manner; both boilers are working at the present day.

In consequence of these occurrences I submit that individually the hammer or the hydraulic is not a reliable test, but should be applied together, rapping the plate with a hammer at intervals as the pressure is increased. This applies more to small boilers where the dimensions are not sufficiently large for a man to get inside to inspect them. The explosion referred to was the third of a series which took place in this colony within a short period, the first being a vertical boiler used in a rice mill, the second a locomotive boiler. The age of the launch boiler was 11 years.

THE STRENGTH OF SPIRAL RIVETED JOINTS.

BY JOHN JASKY.

In building small or large cylinders or other plate work, it is necessary to use one or more iron plates, which are connected by rivets or screws. In riveting such plates the holes must be drilled or punched, which holes should be filled out by the rivets, but practically it is impossible to fill the holes, because the rivets must be smaller in diameter than the holes. These holes weaken the tensile stength of the plate and therefore a greater thickness of plate must be taken.

In calculating the thickness of cylindrical shells it is found that the girth seam is twice as strong as the longitudinal seam. Therefore we have been endeavoring to find another joint of greater strength than the longitudinal joint, and the spiral joint has been built.

The strength of a girth seam is found as follows: Looking at Fig. 1 we find that the power which will break the cylinder at $x - x$ is equal to

$$P = \frac{D^2 \pi}{4} p \qquad (1)$$

in which D is the diameter of pipe in inches, p the pressure per square inch. The plate breaks when this force becomes

$$P = D \pi t T \qquad (2)$$

in which $D =$ diameter of pipe in inches; $t =$ thickness of plate in inches; $T =$ tensile strength in pounds per square inch; $\pi = 3.14159$.

The equation (1) compared with equation (2) gives the equation

$$\frac{D^2 \pi}{4} p = D \pi t T$$

From it the formula for the thickness t is found as

$$t = \frac{D p}{4T} \qquad (3)$$

The second case of breaking is that shown in Fig. 2. It is stated that the pipe breaks in $y - y$. The force which will do it is found as

$$P_1 = DLp \qquad (4)$$

$L =$ the length of pipe, and the force which the pipe can resist is

$$P_1 = 2Lt_2T \qquad (5)$$

Comparing equations (4) and (5) the thickness t_2 is found as

$$t_2 = \frac{Dp}{2T} \qquad (6)$$

Looking at formulas (3) and (6) we can see that the longitudinal seam must be twice as strong as the girth seam. Formula (6) is always used for calculating the thickness of any cylinder in connection with a factor of safety S and the percentage of the riveting E, so that the complete formula assumes the form

$$t_2 = \frac{D \times p \times S}{2T \times E} \qquad (7)$$

It may be easily understood that in riveting there is a great loss of iron plate, so that E never reaches 100 percent; it is always less. To prevent this loss some engineers build pipes with the so-called spiral seam or spiral riveted joint.

Fig. 3 shows a spiral wound around a cylinder. Also it shows the forces P and P_1 acting at any point tending to rupture the cylinder. Both P and P_1 give a resistance P_2, which is found

$$P_2 = \sqrt{P_1^2 + P^2} \qquad (8)$$

or when substituting the values for P and P_1 from formulas (1) and (4), P_2 is found as

$$P_2 = \sqrt{\frac{D^4\pi^2}{16}p_2 + D^2L^2p^2} = Dp\sqrt{\frac{D^2\pi^2}{16} + L^2}$$

Referring to Fig. 4 it may be seen that

$$L = D\pi \tan \alpha$$

and therefore

$$P_3 = Dp\sqrt{\frac{D^2\rho^2}{16} + D^2\pi^2 \tan^2 \alpha} = D^2\pi p\sqrt{\frac{1}{16} + \tan^2 \alpha} \qquad (9)$$

The resistance of the plate is

$$P_2 = \frac{D\pi}{\cos \alpha} t_3 T \qquad (10)$$

and comparing (9) and (10) we have

$$\frac{D\pi}{\cos \alpha} t_3 T = D^2\pi p\sqrt{\frac{1}{16} + \tan^2 \alpha}.$$

From this equation the thickness of plate of the spiral riveted pipe is calculated as

$$t_3 = \frac{Dp \cos \alpha}{T}\sqrt{\frac{1}{16} + \tan^2 \alpha} = \frac{Dp}{T}\sqrt{\frac{\cos^2 \alpha}{16} + \sin^2 \alpha}$$

$$\text{or } t_3 = \frac{Dp}{2T} \times \sqrt{\frac{\cos^2 \alpha + 4\sin^2 \alpha}{2}} = \frac{Dp}{2T} \times \sqrt{\frac{1 + 3\sin^2 \alpha}{2}} \qquad (11)$$

and now substituting the formula (6)

$$t_3 = t_2 \times \sqrt{\frac{1 + 3\sin^2 \alpha}{2}} \qquad (12)$$

and because $\sin \alpha = \cos B$ the equation becomes

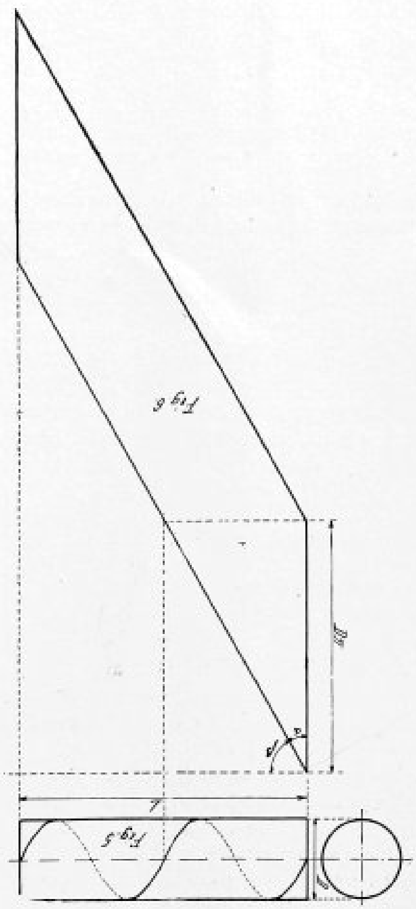
$$t_3 = t_2 \times \sqrt{\frac{1 + 3\cos B}{2}} = t_2 \times f \qquad (13)$$

This formula shows that thickness t_3 is equal the thickness t^2 multiplied by a factor f, which will be never greater than 1. The following table gives the values of f:

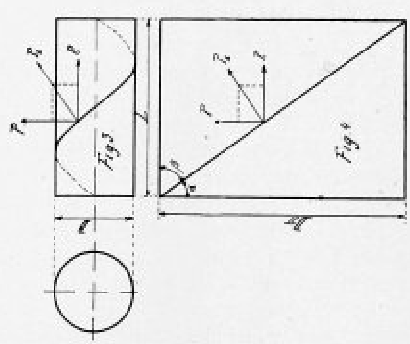
B = 0°	5°	10°	15°	20°	25°	30°
f = 1	0.995	0.990	0.970	0.95	0.92	0.903
B =	35°	40°	45°	50°	55°	60°
f =	0.86	0.83	0.78	0.74	0.70	0.66
B =	65°	70°	75°	80°	85°	90°
f =	0.62	0.58	0.55	0.52	0.51	0.50

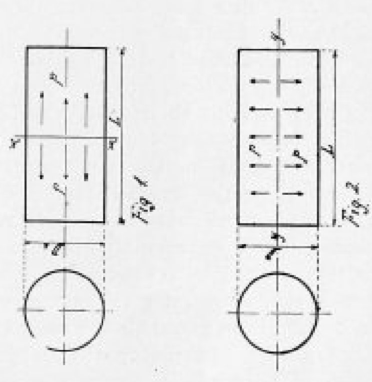
It is easy to see that a great deal of plate may be saved by using spiral riveted joints. This is even more evident when the ratio between the strength of the longitudinal seam and spiral seam is calculated. The ratio called R is

$$R = \frac{t_2}{t_3} = \frac{t_2}{t_2} \times \frac{1}{\sqrt{\frac{1 + 3\cos B}{2}}} \qquad (14)$$



LAYOUT OF A SPIRAL SEAM.





The table below will give this ratio R for various angles:

$B=0°$	5°	10°	15°	20°	25°	30°
$R=1$	1.005	1.01	1.03	1.05	1.08	1.115
$B=$	35°	40°	45°	50°	55°	60°
$R=$	1.15	1.20	1.27	1.34	1.92	1.512
$B=$	65°	70°	75°	80°	85°	90°
$R=$	1.61	1.72	1.82	1.92	1.96	2

Now it may be easily calculated how much plate is saved by using the spiral seam. It is said that the percentage of single riveted joint is about 60 percent. Take, now, an angle $\beta = 60$ degrees—that is, the spiral seam and the girth, form an angle of 30 degrees, or B is the angle between longitudinal and spiral seam—it is found that the spiral seam is 1.512 times stronger than the longitudinal seam, *i. e.*, $1.512 \times 60 = 90.72$ percent. Taking 70 percent as the strength of the longitudinal joint the whole 100 percent and more may be reached.

The layout of a spiral riveted pipe is shown in Figs. 5 and 6. It is very simple and easy to find. The whole length of plate necessary is

$$L_1 = \frac{L}{\cos B} + D\pi \cos B + l \times \tan B = \frac{L + l \sin Z}{\cos B} + DZ \cos B$$

and the width $w = D\pi \sin B + l$

wherein l indicates the lap.

The layout may be found as follows: We have given the diameter D and the length of tube L, also the pressure p. Now it is necessary to choose the angle α or B; having done this the thickness of plate may be found by using the above formulæ. Now draw a line parallel with the axis of tube and perpendicular lines at both ends of the tube. The angle α may be measured on one corner, and from the same corner measure off the circumference of the boiler $D\pi$. From this corner draw a line at the angle α until it cuts the second perpendicular line. Parallel to this line draw another from the end of the first perpendicular line having the length of $D\pi$, and the layout is then readily completed.

BLOWOFF COCKS FOR STEAM BOILERS.

BY CHARLES J. SIMEON.

When the first boiler was made some device was needed to allow the blowing out of mud and loose scale left by the evaporation of the water. In the beginning, steam pressures were low, and steam and water fittings, as they are known to-day, were primitive and clumsy or non-existent. Since that time the demands for high pressures and the better understanding of the requirements have directed a great deal of inventive ability toward the design of special appliances suited to the conditions. These have to handle not only steam and water but loose scale, mud and such other matter as enters the boiler with the feed water, including boiler compounds and homemade scale solvents.

No feed water is pure, and all impurities not deposited and adhering to the shell and tubes must pass out through the blow-off in a more or less concentrated form. The solid portions, made up of grit and pieces of scale, are liable to adhere to the working faces of the cock and to choke or clog restricted passages. On account of their usually isolated and somewhat inaccessible location the blow-off is often more neglected than any other detail in the steam-power plant, despite the fact that, owing to the severe nature of the work done, it is more apt to need attention than any other appliance.

Most men will handle steam apparatus with care, because they have a healthy respect for live steam under pressure, but many will be careless in operating water valves and cocks. If one sticks the first impulse is to resort to the use of a hammer or a long wrench, with the possibility of personal injury or damage to the fitting if this impulse is not checked. It is axiomatic that violence should never be used in operating any steam or water apparatus, but it is especially true of the boiler and all its connections. Too rapid opening or closing of the blow-off may be a fruitful source of trouble. A water-hammer action may be set up which will strain or break the pipe or some of the fittings, or a bit of hard scale may be caught in such a way as to cause cutting and subsequent leaking, while, if care is exercised, the obstruction may possibly be felt and coaxed out by patient manipulation.

Some appliances, excellent for other service, fail when used

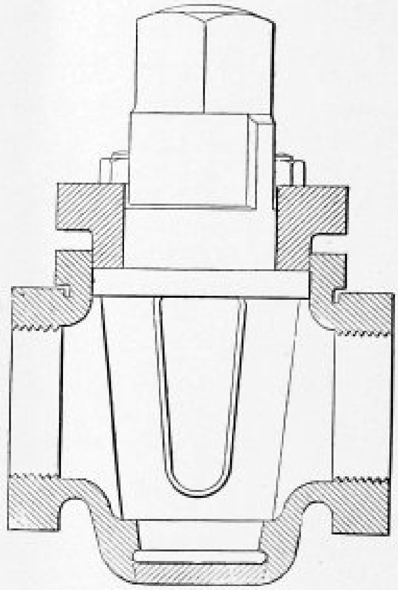


FIG. 1.—FAIRBANKS.

in the blow-off, because the design or the material used is unsuitable. A valve or cock that is easily choked or the working faces of which are exposed to the cutting action of the flow is wrong in design, and one which may be affected by the impurities in the water or is not tough enough to stand the cutting action of the stream of dirty water passing through it, is made of the wrong material. In many designs the aim to overcome these difficulties is shown in ample clearances, unob-

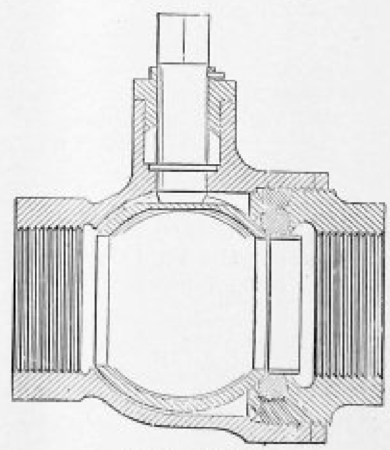


FIG. 2.—HUXLEY.

structed passages, massive proportions and in the use of the strongest and toughest material available.

The first appliance used for the blow-off was the ordinary brass plug cock, because it was the only thing available. It is still used by many engineers on account of its simplicity and cheapness, but by others it is considered unsuitable because mud and scale come to rest against and adhere to the plug, and

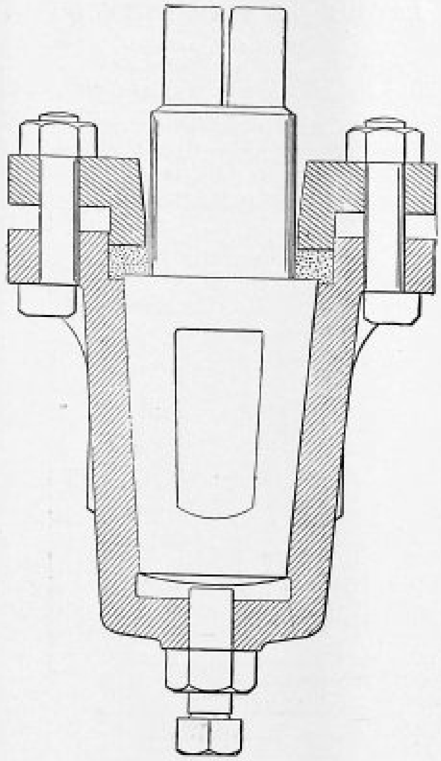


FIG. 3.—WICKES.

when it is turned they are carried with it, cutting the faces of both plug and body, causing it to stick and leak. Also, when it is closed, the sides of the plug and the body nearest to the boiler are exposed to a higher temperature, which causes an unequal expansion, warps both members and makes the plug stick in the socket.

Developments of the plug cock have been numerous and along different lines. The first variation took the form of an

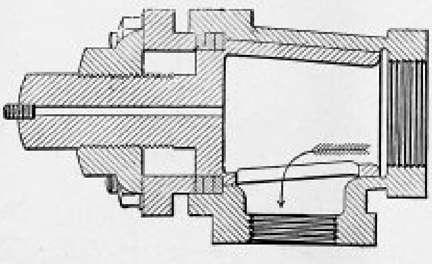


FIG. 4.—SHAW.

iron plug in a brass body, which was less liable to stick from uneven expansion than one made entirely from one metal. This, however, was not a great success, owing to the rusting of the iron plug and the high cost of the brass body. One made with an iron body and a brass plug, though cheaper, was impracticable for the very reason that made the other a partial success. Then one was tried in which both the body and the plug were of iron, given an anti-rust treatment, which reduced the tendency to stick and cut. The form is still used to a large extent.

The next step was, in addition to the anti-rust treatment, to make the seat of some material more pliable than iron or brass. The Fairbanks asbestos-packed cock, Fig. 1, is an example of this type, in which a barffed-iron plug works in a socket of specially prepared asbestos, forced into position by hydraulic pressure. It has a vulcabeston ring on the shoulder of the plug for a top packing.

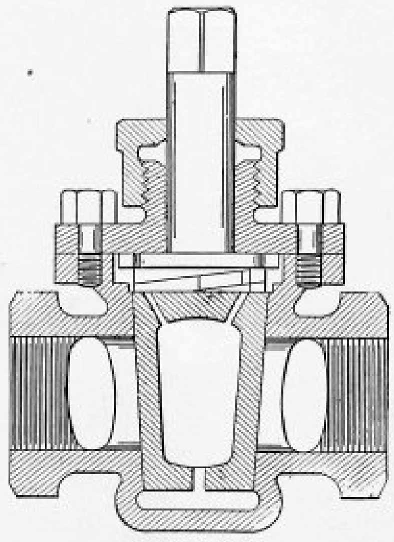


FIG. 5.—HOMESTEAD.

The Huxley, Fig. 2, is somewhat similar in character. It is a plug cock in which the plug takes the form of a hollow sphere, while the seat is formed by a layer of soft packing that is pressed into intimate contact with the spherical surface of the plug by means of a screwed gland.

The next successful cocks are of the type in which a mechanical device is used for loosening the plug in its socket, thus allowing it to move with ease and yet be tight when closed. The Wickes, Fig. 3; Shaw, Fig. 4; Homestead, Fig. 5; Cadman, "split plug," Fig. 6; Anderson, Fig. 7; Bordo, Fig. 8; the Wiltbonco, Fig. 9, and the Ashton, Fig. 10, are examples of this type.

The Wickes is provided with a set-screw and lock, but which permits adjustment of the plug to any degree of tightness desired or readily loosening it if it should stick. The Shaw has a large nut working on the stem of the plug for the same

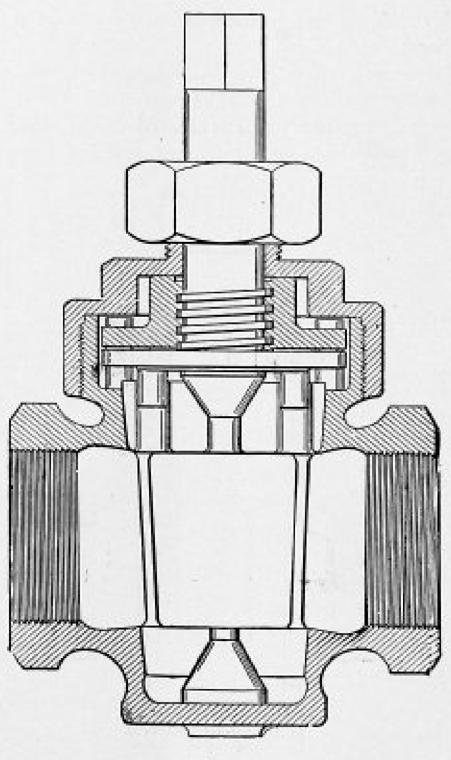


FIG. 6.—CADMAN.

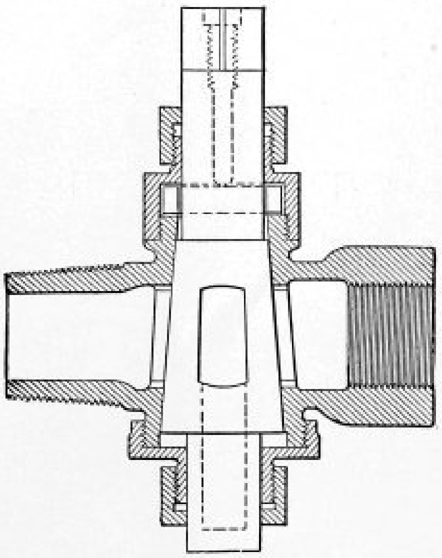


FIG. 7.—ANDERSON.

purpose. In these two the adjustment of the plug must be deliberately made.

The Anderson, Homestead, Bordo and Cadman also provide for adjusting the tightness of the plug in its socket, but the loosening or tightening is done automatically in the act of operating. In the Anderson this is effected by means of two rollers that revolve on a shaft passing through the stem of the plug and run up inclined planes cut in the body. A movement in one direction loosens the plug in its seat and locks it open, while a reverse movement tightens it and locks it closed. The Homestead attains the same results by means of a spiral cam. The Shaw is an example of a cock in which an attempt is made to keep the gritty sediment contained in the water from resting on the working surfaces when closed. To attain this, the inlet is made at the small end of the plug and the outlet at one side, pointing downward. When so placed any sediment from the boiler collects inside and is blown out when opened, instead of coming to rest against the ground surface of the plug.

The above steps trace the development of the plug cock, which was the first piece of apparatus used for this purpose, and is by many engineers still preferred to any other, owing to its simplicity and cheapness.—*Power and the Engineer.*

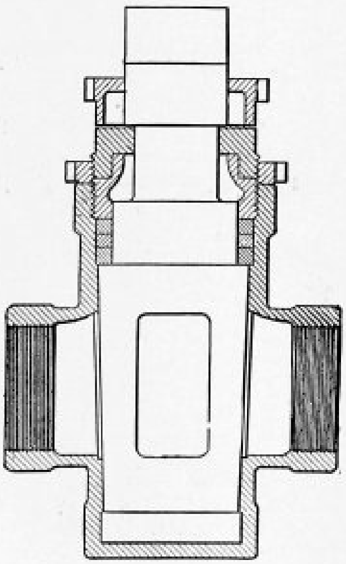


FIG. 8.—BORDO.

LAYOUT OF A TRANSITION PIECE.

BY C. F. AXELSON.

As will be seen this is an irregular piece, which connects a rectangular opening over the boilers to a round flue that enters into the brick chimney. Fig. 1 is the side view, as the piece is set in its position. Fig. 2 shows the narrow side, or a view looking down; this figure is not really necessary for the layout,

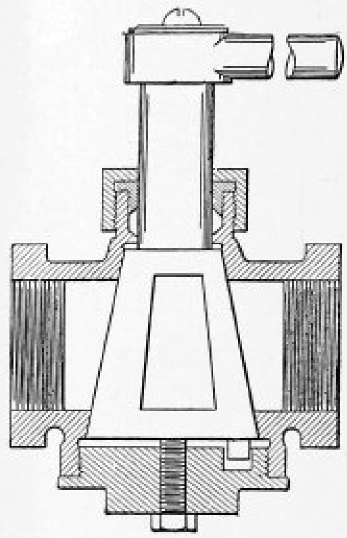


FIG. 9.—WILTBONCO.

as the dimensions can be taken direct from the drawing and applied to Fig. 3.

CONSTRUCTION.

First erect Fig. 1. Draw line *M-M;* set off the diameter from 7 to 19; draw line *C* and line *D* at right angles to line *M-M*. Next locate point *a*, supposing the dimensions 7*b* and *ba* are given on the drawing. Take the distance *a b* from the drawing on the dividers, and with one point on line *C*, as at *b*, strike an arc at *a;* on this arc draw line *E*. With the trams

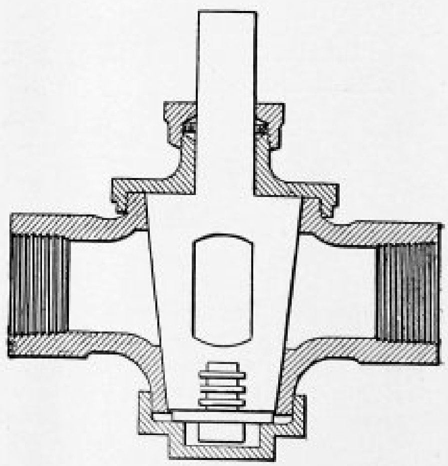


FIG. 10.—ASHTON.

set to the disstance 11*a*, set one point on 11, scribe a line *E*. This gives point *a*. Next set the trams to the length of line *a c*, with one point on *a* strike arc at *c*. Again take length *c* 19 on the trams, and with one point on 19 strike an arc intersecting the one just drawn at *c;* this completes the outline of Fig. 1. Draw line *F* from point *c*. Now line *E* and line *F* will form the height of the rectangle, and line *C* and line *D* give the upper and lower points on the round end, Fig. 3.

To construct Fig. 2, draw a vertical line from *a* through *b* and line *c d*, and with *e* as a center describe the circles on line *a b*, line *c d* and line *M M*, Fig. 1. Draw lines tangent to those circles and parallel to line *C*, Fig. 1. On line *N N*, Fig. 2, set the distance 7-19, Fig. 1. From 1 and 13, Fig. 2, draw lines to Fig. 3. This gives four points on the round end. Now take the distance *a b* from the drawing; set off from *a* to *b* and from *d* to *c*; draw a line, which is now the slant line *a o c*, and 5. Distance between line *N N* and line *d c* is the vertical height of the short side; extend line *d c*. Draw vertical line *o x*. To avoid confusion, the circle and triangles are in four sections—*A*, *B*, *C* and *D*.

For good reason Fig. 5 is placed lower down on this drawing instead of on line *a b*, Fig. 2, which is the proper place. Draw the base line *H H*, Fig. 5. Now take the distance *f* 13, Fig. 2, on the trams, and set this off from *o* to *x*, Fig. 5. With

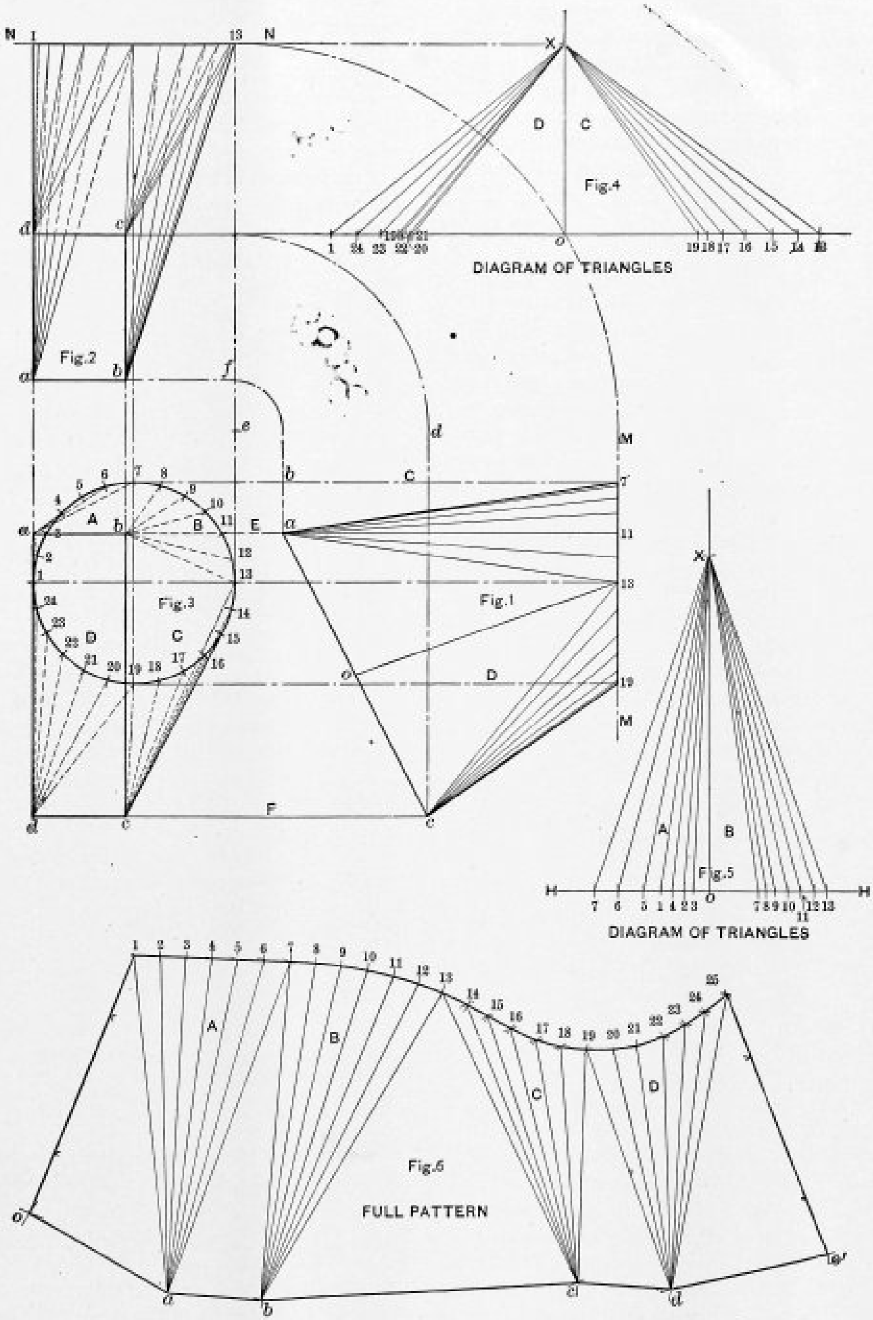


Fig. 1. Extend line 1 *d a* through Fig. 3, which makes the fourth side in the rectangle, with center lines drawn from Figs. 1 and 2 intersecting in Fig. 3. On this, as center, describe the circle.

Now divide the circle into a number of equal spaces, in this case 24, and draw lines as shown. Beginning at point *a* draw *a* 1, *a* 2, *a* 3, *a* 4, *a* 5, *a* 6, *a* 7. Step over to *b*, and with *b* as a center draw *b* 7. Now proceed the same as in section *A*. When number 13 is taken step to *c*, draw *c* 13-19; then step over to *d* and draw *d* 19-1. Next erect the triangles, Figs. 4 the dividers take the distance *a* 1, Fig. 3, and on point *o* as a center strike an arc as at 1 on line *H H*. Using *a* as a center for section *A* take all numbers to 7; set them down on the base line *H H*, and number them as shown. Now step over to the point *b*, section *B*. Take the distances *b* 7; set them off to the right from *o* to 7; continue in that way till 13 is taken, completing the triangles for the long side.

We will now go back to Fig. 4 to finish the bases for our triangles. First step to Fig. 3, and using *c* for a center, section *C*, take distance *c* 13, set this off from *o* to 13, Fig. 4. Proceed the same as in the preceding sections, then step over to *d*, section *D*. Set this off on left from *o*, and draw lines from *x* to all points on base line.

DEVELOPMENT OF PATTERN.

At first make calculations for the seam. In the position of Fig. 1 the straight side is shown, and as the flat part here gives the true length line *o* 13 can be taken for the seam, point *o* being the center on line *a c*. Now locate point *a*, Fig. 6, and distance *x* 1, Fig. 5, on the trams. Set one point on *a*, Fig. 6, strike an arc at 1 with the dividers already set one spacing, Fig. 3. Strike a small arc at 2, again with the trams on line *x* 2, Fig. 5, step to *a*, strike an arc intersecting the small arc. With the dividers on 2 strike another arc for the next line. Continue that way with numbers 3, 4, 5, 6 and 7. Draw lines and section *A* is drawn. Next take distances *a b*, Fig. 2. Set off from *a* to *b*, Fig. 6. Take the distance *x t*, section *B*, Fig. 5. With one point of the trams on 7, Fig. 6, strike an arc, cutting the one struck from *a*. Draw the line *a b*, also line *b* 7. Next take the distance *x* 8, and on *b* as a center for section *B* strike an arc at 8, and with the dividers from 7 to 8 now proceed the same as in section *A* to 13. Draw the line. Next take the distance *a c*, slant line, Fig. 1; set on *b*, Fig. 6; strike an arc at *c*. Next take the line *x* 13, Fig. 4, and on 13, Fig. 6, scribe an arc as at *c*. Now take line *x* 14; step to *c*, which is the center for section *C*, and strike an arc at 14, with the dividers lay down 13, 14; when 19 is taken step over to *a* on the pattern, and distance *a b* is set off from *c* to *d* going over to Fig. 4. Line *x* 20; step to *d*, Fig. 6; strike arc at 20 and space 19, 20 on dividers. Continue the same as in the preceding sections and draw line *d* 1'. Now take distance *o c*, Fig. 1. Set on *d*; strike arc at *o'*; step over to *a* at the left; scribe arc *o*. Next take lap line *o* 13, Fig. 1; step to 1, Fig. 6, intersect the arc just drawn at *o*. Again step to 1' on the right; strike point *o'* and draw lines through those points. For the round end take a thin lath, lay it down on the points and draw a curved line, touching all points, completing the pattern. The lap and flange must be added.

DESIGN, CONSTRUCTION AND INSPECTION OF LOCOMOTIVE BOILERS.*

There were three subjects mentioned for your committee to consider, *i. e.*, the designs of boilers, the construction of same and also inspection, and, as either of the subjects were sufficient for a very lengthy report, your committee considered only the subject of locomotive boiler inspection. Your committee has not as yet had time to enable it to formulate rules and regulations covering the inspection of locomotive boilers, but it has thoroughly investigated the subject of boiler explosions and failures and casualties to employees and others resulting therefrom.

Blanks were forwarded to all of the principal railroads of the United States, asking for information in regard to boiler inspection rules and regulations and also as to casualties resulting from boiler explosions of all natures, and attention is called to the following information received in reports from 157 railroads replying to the question as to the number of boiler explosions and failures and casualties to employees and others resulting therefrom during the period from Jan. 1, 1905, to Nov. 1, 1909. These 157 railroads own and operate 43,787 locomotives and 157,169 miles of roadway, and during the period from Jan. 1, 1905, to Nov. 1, 1909, they made 6,012,057,-467 locomotive miles. We estimate that there are about 58,000 locomotives in service in the United States; therefore reports which we have received cover about 75 percent of the total number of locomotives in operation in the United States.

* Abstract of report presented before the Master Mechanics' Association.

Explosions and failures of locomotive boilers are divided into five classes, as follows:

Explosions of fire-boxes.
Explosions of boiler shells.
Boiler-fitting failures.
Rupture of flues.
Damage by burning.

Explosions of boiler shells and fire-boxes, or damage by burning, etc., are usually due to low water. Of the failures reported, 98.3 percent were due to low water and 1.7 percent to other causes. Of the failures due to low water, 98.6 percent were due to the failure of the men handling or in immediate charge of the locomotive to maintain a proper supply of water in the boiler; the remaining 1.4 percent were due to other causes.

Automatic devices, either to maintain the water supply or to act as an alarm when proper supply is not provided, have been proposed and given consideration, but it has been determined that such devices are unreliable, and have had the effect of taking away from the men in charge their accepted responsibility.

A statement of the explosions, failures and casualties is given in the following table:

	No.	Average per Year.	No. Killed.	Average per Year.	No. Injured.	Average per Year.
Low water:						
Explosion of boiler shells.....	14	2.9	20	4.1	16	3.3
Explosion of fire boxes........	246	50.9	127	26.3	144	29.8
Damaged by burning.........	2,499	517.0	15	3.1	57	11.8
Ruptured flues..............	66	13.6	0	0.0	3	0.6
Fitting failures..............	25	5.2	0	0.0	4	0.8
Other causes:						
Explosion of boiler shells.....	6	1.3	10	2.0	7	1.4
Explosion of fire boxes.......	2	0.4	1	0.2	1	0.2
Damaged by burning.........	40	8.3	1	0.2	1	0.2
Total......................	2,898	599.5	174	35.9	233	48.1

In the above table, of the 407 killed and injured, 386, or 94.8 percent, were due to accidents caused by low water, while the remaining 21, or 5.2 percent, were from other causes, some of these being the result of or incident to wrecks, and a small number are thought to be due to accidents caused by defects in design, material, workmanship or the physical condition of the boilers or fittings, but it is doubtful if any of them could have been prevented by any method of inspection in addition to that which is now in force.

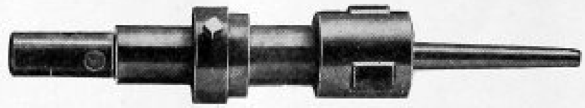
In addition to the failures, as shown above, there were also other failures, as follows:

	No.	No. Killed.	No. Injured.
Rupture of flues........................	3,204	8	21
Boiler fitting failures..................	1,609	2	51
Total..............................	4,813	10	72

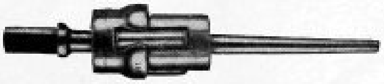
In analyzing the accidents due to the latter causes, attention is invited to the item of ruptured flues, shown to be 3,204. This, however, covers the record of an average number of 42,200 locomotives per annum for a period of four years and ten months. Assuming 250 flues to each locomotive boiler, the result shows one flue failure per year to each 15,912 flues in service, or, stated in other terms, the percentage of flue failures to the number of flues in service is six one hundred thousandths of 1 percent. Both of the above comparisons constitute an excellent endorsement of the present high standard of physical condition of American locomotive boilers, and show how small an opportunity there is to improve the present practice of railroads.

Of the 1,634 cases of boiler fitting failures reported, 1,609 are somewhat indefinite and apparently include failures occurring from causes other than primary failure of the fittings, such as wrecks or other external accidents, many of them

"Boss" Roller Expander (Hand Use)



Arch Flue Expander



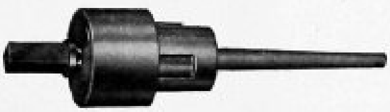
"Boss" Roller Expander (Self-Feeder)

FAESSLER

BOILER MAKERS' TOOLS

ARE STEEL THROUGHOUT

Universal Expander (Hand Use)



Universal Expander (Self-Feeder)

This strong point is but one of many that skilled boiler makers invariably recognize in Faessler Tools.

Space here does not permit describing each in detail. If it did, we think we could easily convince you beforehand of the ability of any Faessler tool to withstand the hardest knocks of severe service and do first-class work under trying conditions.

But better than this, we want you to see for yourself in your own shop that our claims are not exaggerated. Tell us the size and kind of tools needed, and we will supply your wants on condition that our tools must prove highly satisfactory in every way or may be returned at the end of a 30-days' trial.

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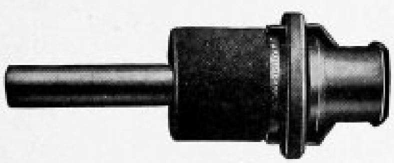

Rapid Beading Expander

J. FAESSLER MFG. CO.

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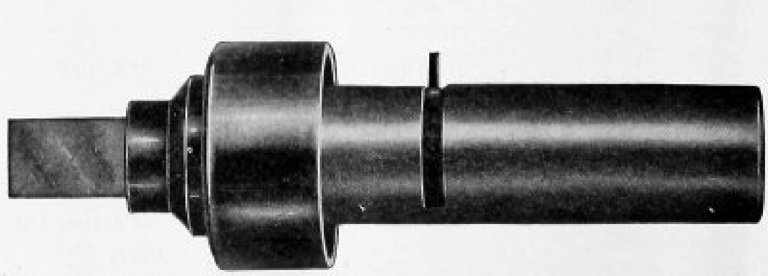
Rapid Beader Tool

Improved Sectional Expander



"Perfect" Flue Cutter

doubtless being of a minor character. At the time the different railroad companies were asked for information as to boiler explosions, casualties, etc., they were also asked to supply copies of their rules and regulations for the care and inspection of locomotive boilers. A review of such rules and regulations as were submitted shows that a very thorough and vigorous inspection of locomotive boilers is being maintained and recorded, and the rules prescribe very thorough instructions as to the proper care of the locomotive boilers.

These rules and regulations plainly show that different localities require different rules and regulations for the care and inspection of locomotive boilers. In some localities the water that is obtainable for use in these boilers is very detrimental to the boiler; therefore, very frequent inspections must be made, while in other localities the water conditions are very favorable, and the period between inspections may be longer. In a general way the rules and regulations for the care and inspection of the boilers must be made to meet the conditions under which the boilers are being operated, and no general rules will apply in a practical way.

From Senate Document No. 682, the following information was obtained: The average number of employees killed and injured per annum, on account of boiler explosions on locomotives, for the period from Aug. 1, 1903, to Nov. 1, 1908, was 49.7 employees and others killed and 134.2 injured. This Senate document covered a period of five years and three months, and includes all the locomotives in use during that time. During the period from Jan. 1, 1905, to Nov. 1, 1909 (four years and ten months), the replies from 157 railroads, having 43,787 locomotives, with a mileage of 6,012,057,467 miles, show that for said period the average number of employees killed and injured per annum was 38.0 killed and 63.1 injured. As the roads replying only represent about 75 percent of the locomotives of the country, it will be assumed that the figures represent about 75 percent of the casualties, which would make these figures approximate those furnished by the government as to the number of persons killed and injured, namely:

Average number killed, reported by government, 49.7; average number killed, reported by railroads, 50.6 (estimated); average number injured, reported by government, 134.2; average number injured, reported by railroads (estimated), 84.1.

Prospects for the Young Boiler Maker.

BY EL'GOMO.

Frequently we hear the remark from young men in the boiler shops, "we don't get a show." The writer is of the opinion that the fault is in the man and not the condition. Realizing that the all-around capable boiler makers of the old school are thinning out, who will fill their places? Young man, can we count on you? When we consider this great country, the Canadas, the South American States and Islands, also the United States navy, all of whom are in the market for young men who can give results, where can we enlist this army? To those who are willing to give hard work for good returns the writer desires to appeal. While a number may have been unable to obtain the advantage of our common schools, it should prove no barrier in your behalf. It is up to you. No matter how small the shop, others have made good. Why not you? If you are sincere, just try. But if you are a past master in the art of cigarette smoking, and what usually goes with it, don't waste your time in boiler shops, as the average master has no use for such.

To the sincere apprentice, the writer would offer a few suggestions. Don't get smart. Don't expect to become a boiler maker before you have learned it. Years do not count, but results. Your foundation can be laid at the rivet fire, or any part of the work assigned to you, such as helping about the shop, keeping tools in place, etc. Do not be afraid that you will do more work than the other boy. Watch how work is done about the shop; keep tabs on all work possible. The flanger or fitter, or layer out, may want help, or the man at the drill or punch. There is a show for you, if you wish to be shown. Don't monkey with the machinery about the shop, it may lead you into trouble. These suggestions should keep you busy for a year at least.

In case you are sent out with a gang, keep at it. Do your part, there may come an opportunity where you can render good service. Thoughtful boiler makers remember small favors. You may have work with the sheet iron gang, helping, holding on, driving small rivets, etc.

It may be of interest to the young apprentice to learn something of the writer's early experience. I obtained work in a small railroad boiler shop in the year 1878 at the age of 20 years. I took to the work like a duck to water, heating rivets, holding on, helping at such work incidental about a small boiler shop, and in about a year I had a show at repairing ash-pans, locomotive tanks and other work.

Within three years I was in a small contract shop where locomotive and stationary boilers were made, also repair work done. Tools were scarce, and the boss was a hustler from the word go. Well, I remember my first chance at riveting (top rivets) by hand. A riveter on the job thought the work was too strenuous; chucked it up, and as we were a man short the boss told me to try my hand. I was pretty well used up when the 6 P. M. whistle blew, and thought I should have to give up, but after getting warmed up the next day I made good. The rest was easy. I had a show at all kinds of work, including repair work about the coal mines and other places.

I shall never forget my first hard fall. (The young boiler maker is liable to think he knows it all.) The boss was called away, leaving instructions to have the old furnace cut out of a certain upright boiler, and the old sheet straightened out as a template to mark off the new sheet. The writer (like unto others) though best to lay out the new sheet himself. Well, from last reports that sheet was on the scrap heap lying outside, and may be there still.

Moral:—"Better do as you are instructed."

Performance of the Jacobs-Shupert Fire-box.

During the month of April, 1909, a fire-box of the Jacobs-Shupert type was applied to locomotive No. 917 on the Arizona division of the Santa Fe Railway system. According to Mr. M. H. Haig, mechanical engineer of the Atchison, Topeka & Santa Fe, this fire-box has since been in continuous service, giving very satisfactory results. In fact, no repair work has been done on the fire-box since it was placed in service, and there has therefore been no cost of maintenance with this fire-box. Since the first of the year four Mallet type locomotives, equipped with Jacobs-Shupert fire-boxes have been in service, and the performance of these fire-boxes also has been entirely satisfactory. Two of these locomotives are in passenger service and two in freight service. As a result of the good service rendered by the first few fire-boxes placed the use of this type of fire-box has been extended materially on the Santa Fe, and forty Prairie Mallet type locomotives are now being delivered. In addition to these, twenty-three Atlantic type locomotives and twelve Pacific type locomotives are being constructed with fire-boxes of the Jacobs-Shupert type, and these locomotives will be in service within a few months. Besides these, fire-boxes of the same type are being built at the company's shops for application to heavy freight locomotives, and will be in service during the coming winter.

The Boiler Maker

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Is Low Water Responsible for the Majority of Locomotive Boiler Explosions?

From statements made in a report presented before the last Master Mechanics' convention by a committee which investigated the subject of locomotive boiler inspection, we are informed that 98.3 percent of the explosions of locomotive boilers have been due to accidents caused by low water, while the remaining 1.7 percent were from other causes, some of these being the result of or incident to wrecks, and only a small number are thought to be due to accidents caused by defects in design, material, workmanship, or the physical condition of the boilers or fittings. If these figures are to be accepted as stated, there is obviously very little opportunity to decrease the number of locomotive boiler explosions by any system of inspection more thorough than that now maintained by the railroad companies. The remedy must lie in some means of preventing shortness of water in the boiler while under steam. However, everyone, we think, will agree that there are far too many explosions of locomotive boilers in this country, and that there is an element of carelessness or neglect somewhere which causes these. The committee report which we have quoted, and which is published elsewhere in this issue, is based on information which was carefully gathered from 157 railroads, and so far as it goes there can be no doubt as to the accuracy of the information. There is one point, however, on which such information, no matter how conscientiously given by the railroad companies, might be in error, and that is regarding the causes of explosions. The cause of a locomotive boiler explosion is not always investigated with the thoroughness which such an accident deserves, and a good many people will refuse to accept as final the opinion that so large a percentage of these explosions is due to low water. This does not agree with the facts as ascertained in other countries —notably in England. Whereas, according to the committee report of the Master Mechanics' Association, there is a yearly average of 36 killed and 48 injured in the United States by locomotive boiler failures alone, in the United Kingdom the average total of persons killed by every casualty arising from failure of steam apparatus, including stationary and marine boilers, and many trivial failures which only rank officially as explosions on account of the exacting nature of the Board of Trade returns, is 28, and the average injured 58. Thirty years ago, even in England, boiler explosions were generally ascribed to overheating through shortness of water consequent on carelessness of the attendant. Defective material, workmanship or fittings were seldom suspected, as is the case now on American locomotive boilers, but at the present time in England the latter are known positively to be the principal causes of boiler explosions in the majority of cases. This seems to indicate that, if the causes of locomotive boiler explosions were investigated in America by unprejudiced outside parties as carefully as they are in England a different verdict than that of low water might be returned in the majority of cases. However, with the information at hand this is an assumption which can neither be affirmed nor denied, but it is a matter which we believe should be sifted to the bottom so that the facts can be thoroughly established.

Boiler Manufacturers' Association.

As stated in the announcement of the twenty-second annual convention of the American Boiler Manufacturers' Association, which is to be held at the Auditorium Annex, Chicago, Oct. 10, 11, 12 and 13, a pamphlet was issued last year by President Meier, telling what the association has accomplished during recent years. Unlike most organizations of this character, this association has had no salaried officers who could spend their whole time in active work in the interests of the organization, and that so much has been accomplished by the officers of the association, who invariably have been men the greater part of whose time was necessarily devoted to their own business interests, speaks well for the faithfulness and sacrifice with which these officers have performed their duties, and the loyalty which the members have shown in carrying on the work of the association. However, in order for the association to maintain a continual growth and take a leading part in bringing about the highest standard of boiler construction, in establishing uniform inspection laws, as well as in safeguarding the interests of the individual manufacturers, it would seem that the time has now come when the secretary of the association should be provided with a salaried assistant, who could devote his whole time, or a portion of his time, to the active work of the association. Very little can be accomplished by intermittent and desultory efforts, but continuous, wideawake, progressive action would undoubtedly go far towards bringing about the results which have so often been emphasized as both desirable and necessary.

Boiler Manufacturers' Convention.

The twenty-second annual convention of the American Boiler Manufacturers' Association will take place at Chicago, Ill., October 10, 11, 12 and 13. This will undoubtedly be the most popular convention the American Boiler Manufacturers' Association has ever held. Last year a pamphlet edited by President E. D. Meier was published setting forth a few brief facts relative to the good work the association has accomplished. This year there is much important work to be discussed, which should be of more than ordinary interest to all persons engaged in the manufacture of boilers. By coming to these meetings and assisting in the further upbuilding of this great industry every boiler manufacturer surely will be impressed with the great good it will do. Time and again attention has been called to the well-worn phrase, "In Union there is Strength," and none can fail to admit that if there was more union and harmony of interest existing among competitors the benefit to be derived would be incalculable.

Is it right to let every Tom, Dick and Harry traffic in any old boiler that has been lying around on a vacant lot, out of commission for years? With the help and assistance of the members the American Boiler Manufacturers' Association can by united effort more speedily prevent this by the introduction of proper legislation toward securing a National uniform boiler inspection law. Lives are at stake every day from boilers in service that ought not to be, and boiler manufacturers can help remedy this evil.

Besides the business sessions of the association, ample entertainment will be provided by the Supply Men's Association, so that a pleasant time is insured for the ladies and guests of the members. One of the features of this year's convention will be a trip to Gary to see the largest steel plant in the world.

COMMUNICATIONS.

Efficiency of a Boiler Plant.

EDITOR THE BOILER MAKER:

One of the questions and answers in your September issue suggests the following:

The efficiency of a boiler plant is the ratio of the difference between the heat in the steam (delivered by the boiler) and the heat in the feedwater to the heat that would be developed by the perfect combustion of the fuel.

The following example illustrates the foregoing statements:

DATA.

1. The heat of combustion per pound of a certain fuel is known to be 14,000 British thermal units.

2. The number of pounds of such fuel used at a boiler test was 3,500 per hour.

3. The number of pounds of feed water evaporated into steam per hour was 30,000.

4. The temperature of the feed water was 80 degrees F.

5. The steam pressure carried was 90 pounds gage, or 105 pounds absolute, we will say.

Question.—What is the efficiency of the boiler in question?

METHOD OF OPERATION

1. Total heat in 1 pound of steam at 105 pounds absolute pressure (as per steam table) = 1182.945 British thermal units.

2. Temperature of feed water = 80 degrees F., and 80 degrees — 32 degrees = 48 so-called British thermal units contained in the water, above 32 degrees F.

3. So that, 1182.945 British thermal units — 48 British thermal units = 1134.945 British thermal units per pound balance.

4. Now, 1134.945 British thermal units × 30,000 pounds water evaporated = 34,048,350 British thermal units absorbed by the water.

Each pound of coal contains 14,000 British thermal units, and the total coal consumed = 3,500 pounds. Total heat supplied = 14,000 × 3,500 = 49,000,000 British thermal units.

5. The efficiency is therefore $\frac{34{,}048{,}350 \times 100}{49{,}000{,}000} = 69.4$ percent.

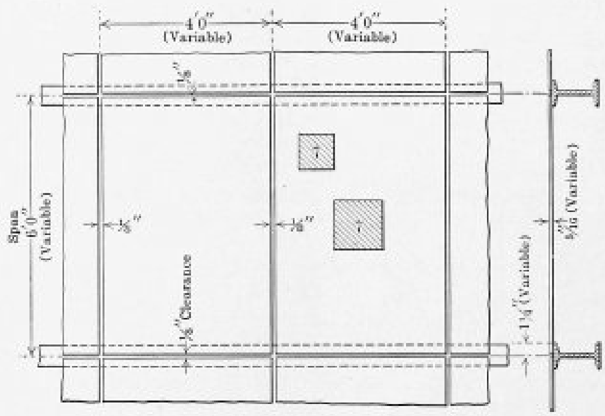
CHAS. J. MASON.

Scranton, Pa.

Strength of Floor Plates.

EDITOR THE BOILER MAKER:

The writer wishes some information relative to the most practical formulæ for calculating the uniformly distributed load and also the imposed load at any point on the surface of plain rectangular wrought steel floor plates of varying thicknesses. As shown in the sketch, the plates are supported



Note: "L" indicates variable position of different weight imposed loads.

on two edges only, the other two edges being simply butted against the edges of the adjacent floor plates. The plates are thus easily removed.

The above applies to the construction of charging floors for gas houses and similar requirements, and I trust that some of the readers of THE BOILER MAKER who have had experience with this kind of work may be able to give some information along this line.

EDWIN E. ROHRER.

Coatesville, Pa.

PERSONAL.

CHARLES BOOTH, formerly manager of the New York office of the Chicago Pneumatic Tool Company, sailed for Europe October 4, and will assume general supervision over the European business of this company.

M. M. MCCALLISTER, formerly foreman boiler maker of the Michigan Central shops, Collinwood, Ohio, has recently accepted the position of general foreman with the Erie City Iron Works, Erie City, Pa.

A. ANDERSON, for several years connected with the Mexican National Railway at San Luis Potosi, Mexico, has moved to Topeka, Kan., where he is now gang foreman of the Santa Fe Railway.

TECHNICAL PUBLICATIONS.

Official Proceedings of the Fourth Annual Convention of the International Master Boiler Makers' Association. Size, 5¾ by 8¾ inches. Pages, 194. Numerous illustrations. New York, 1910: Harry D. Vought, secretary.

Since a very complete report of the fourth annual convention of this association was published in our June issue, it is hardly necessary to enumerate again the many valuable features of this convention. The proceedings contain the complete report of all the discussions of the papers, besides the subject matter of the papers themselves. Mr. McBain's address on the "Inequality of Expansion of Locomotive Boilers and the Possibility of Eliminating the Bad Effects Therefrom" is published in full, together with the illustrations which were used in the stereopticon lecture which he gave at the convention. The secretary of the association has published the proceedings in attractive form, and every boiler maker will find it well worth the trouble to obtain a copy.

Proceedings of the International Railway General Foremen's Association. Size, 6 by 9 inches. Pages, 142. Numerous illustrations. Two Habors, Minn., 1910: L. H. Bryan, secretary.

The report of the sixth annual convention of this association comprises the greater part of the proceedings. The convention was held at Cincinnati in May, and as the attendance was large much valuable and instructive information is contained in the proceedings. Among the subjects discussed are the following: Method Used by the Great Northern Railway Company to Clean Ashpans to Comply with the Inter-State Commerce Law; The Use of Commercial Gas as Fuel; The Advisability of Installing Hot-Water Washout Filling Systems; The Use of the Oxy-Acetylene Process of Welding Fireboxes, Boiler Sheets, Frames and Other Locomotive Work; Wide Fireboxes, Superheaters and Location of Point of Water Delivery. A number of interesting and valuable addresses by various well-known railway officials are also included in the proceedings. A list of the officers, committees, a copy of the constitution and by-laws, a list of names and addresses of the members, and a list of the members present at the annual convention are also included in the volume.

Power Gas and the Gas Producer. By J. C. Miller, M. E. Size, 5¼ by 8 inches. Pages, 184. Illustrations, 20. Chicago, 1910: Popular Mechanics Company. Price, $1.00.

Wonderful strides have been made during the last few years in the development of gas producers for power and industrial purposes. While the adoption of this form of power seems at first thought to be directly antagonistic to the interests of boiler makers, yet the apparatus itself must be constructed in a boiler shop, and its details are, therefore, of interest to boiler makers. Since producer gas has gained such prominence in the mechanical world numerous books have been written regarding the subject, some of which have been very complete, but most of them have approached the subject from a theoretical standpoint and are, consequently, somewhat too complicated for the use of one who is merely seeking general information. The book under review has been written so that it can be understood easily by one who is not familiar with the subject. It sums up in a very clear and instructive manner the various types of gas producers, the nature of fuels used, details of construction, the economy, reliability and troubles which are likely to be met in the operation of such a plant. One chapter gives some interesting comparative figures showing the cost of steam and gas power plants.

Rules and Formulæ. Endorsed and adopted by the International Master Boiler Makers' Association. Size, 3¾ by 5¾ inches. Pages, 65. 95 Liberty street, New York, 1910: The International Master Boiler Makers' Association. Price, $1.00.

As announced in our June issue, the International Master Boiler Makers' Association have published a collection of rules and formulæ of value to those engaged in the designing and inspecting of steam boilers, generators and other receptacles holding pressure. With the rules and formulæ are incorporated also some valuable suggestions pertaining to good practice. The work of compiling these rules was done by a committee of the association, headed by Chas. P. Patrick, which presented its report at the 1909 convention. This report of the committee was endorsed by the association, and it was considered that the rules and formulæ thus collected were of sufficient value to warrant publication and distribution to members of the association. This was made possible through the generosity of a good friend of the association, and, in order that the book might be available for the use of outsiders, a sufficient edition was published, so that it could be placed on sale.

The authors of the work call special attention to one of the rules relating to the staying of flat surfaces by screw stays having heads riveted. A special study was made of this subject owing to the varied results obtained by the different rules commonly used. The rule approximate to that of D. K. Clark, suggested by Mr. Patrick, was endorsed after all points were considered. Other rules on this subject are given, however, for general information. Little original matter is claimed for the book, although the rules and suggestions which it contains were selected from many treating on the different subjects, and they are believed to be the best obtainable.

Self-Taught Mechanical Drawing and Elementary Machine Design. By F. L. Sylvester, M. E., with additions by Erik Oberg. Size, 5 by 7½ inches. Pages, 333. Illustrations, 218. New York, 1910: Norman W. Henley Publishing Company. Price, $2.

A common fault with many text-books is that they are too advanced or theoretical to be of use to a practical mechanic, and when it comes to the selection of a suitable book for the man who has little or no knowledge of theoretical principles it is a difficult matter to find one which will answer his purposes. It is this lack of a suitable elementary book in mechanical drawing that has led to the publication of the work under review. The author has kept his aim well in view throughout the entire work, and it is primarily and essentially an elementary treatise and, as such, can be heartily recommended to practical men who wish to gain some knowledge of mechanical drawing and the common calculations necessary for machine design.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—Will some flange turner kindly inform me of the best way to bend angle iron on a sectional flanger? I have some angle iron rings to make. The iron is 4 inches by 6 inches by ⅝ inch, and the rings are to be 69 inches outside diameter, with a 4-inch web angle turned in. I also wish to know how to figure the proper length of the bars to make these rings?

A.—Angle iron rings are usually either bent hot by hand by an angle smith or they may be bent cold on a bulldozer. If you wish to use a sectional flanging machine some dies could be made similar to those used on a bulldozer, and by using the horizontal plunger of the flanging machine as the plunger of a bulldozer the work can be performed in the same manner s on a bulldozer.

The length of the bars to make the rings is figured as follows:

The diameter to be used in figuring the length is equal to the diameter of the finished ring minus the sum of 1/3 the width of the web of the bar which is turned in and the thickness of the web. In this case the width of the web of the bar which is turned in is 4 inches, 1/3 of this is 4/3, and this added to the thickness of the flange, which is ⅝ inch, would be 47/24 inch, or, 1.96 inch. The diameter is then equal to the outside diameter of the ring minus 1.96, or:

$$d = 69 - 1.96$$

$$d = 67.04 \text{ inches.}$$

Multiplying 67.04 by 3.1416, we find the length of the bar to be 210.61 inches, or 17 feet 6 19/32 inches.

ENGINEERING SPECIALTIES.

Queen City Safety Forming Press or Multiple Punch.*

A large multiple punch, which is the product of the Queen City Punch and Shear Company, Cincinnati, O., is shown in Figs. 1 and 2. This machine has been built for punching angle-bars, punching two at a time on one side in one stroke, thereby completing the bar in one operation on both sides. One of the distinctive features of these presses is the oscillating table, which eliminates all danger of injury to the operators. This oscillating movement is obtained by a large face cam, which, on the particular machine illustrated, is mounted on the main driving shaft. This cam transmits the required movement by suitable levers to the shaft on which the table is mounted. With this arrangement the table and its dies are moved from under the plunger when the work is finished so that the latter can be removed and a new blank inserted without danger of accident. Fig. 1 shows the table in the working position, while Fig. 2 shows it moved forward, where it is allowed to remain stationary to permit the removal of the finished work and the insertion of a new blank.

Presses of this class are built with either a single or double set of dies. When a double set of dies is employed two operators are required, one being stationed at the rear of the machine and the other at the front to feed and remove the work. The action of the double-action type of machine is as follows: After the work has been formed in one set of dies, the latter remains stationary until the plunger is partly raised. Then the dies in which the work has been formed or pressed, as the case may be, move forward to the operator, who removes the finished work and inserts another blank. In the meantime the opposite set of dies is receiving the plunger so that the machine is in operation continuously. With the single type press, such as is illustrated, the general operation is practically the same as with the double dies, except that only one operator is required. The double action type can be employed on a multiple punch when the work is light and can be easily handled, but when it is comparatively heavy the single action is recommended.

It will be seen from the foregoing that the oscillating table makes it unnecessary for the workman to place his hands or fingers near the dies while feeding or removing the work, as the dies come forward to a safe position. These machines are provided with an automatic safety stop clutch, which stops the plunger when the latter is in its upward position. The particular press illustrated measures 62 inches between the housings and it weighs approximately 20,000 pounds. It is equipped with machine-cut gears, which insure a smooth and noiseless operation. These machines are built in various sizes and styles to meet the necessary requirements or nature of the work to be handled.

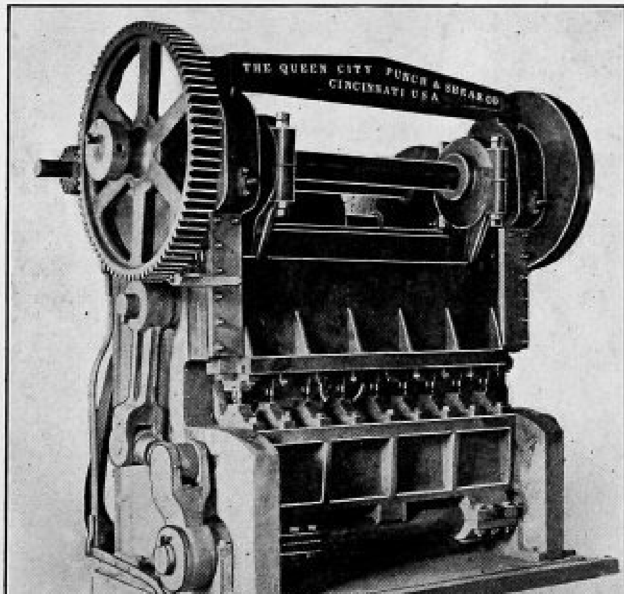


FIG. 1.

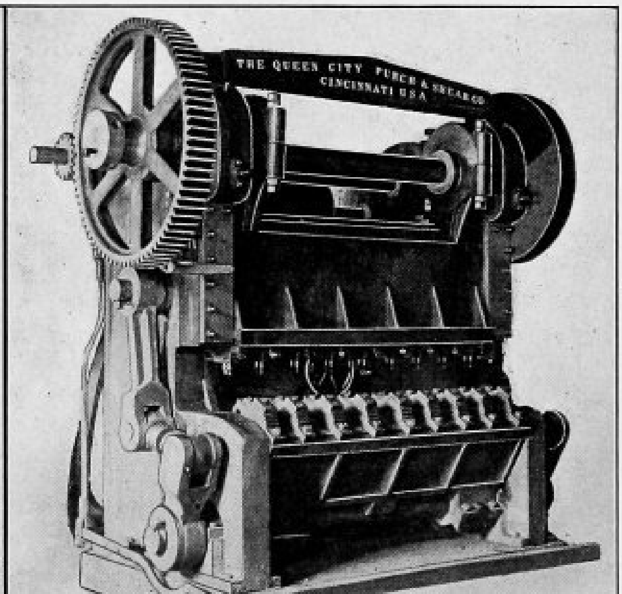


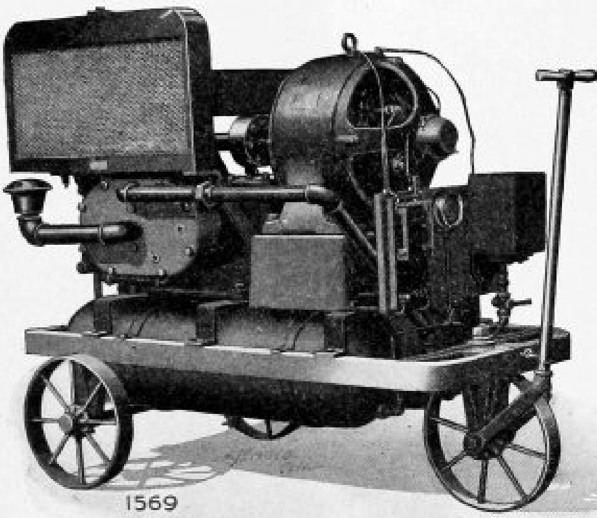
FIG. 2.

* Cuts reproduced by courtesy of the Iron Age.

A Portable Air Compressor.

In boiler shops, as in other industries, the use of pneumatic tools has proven a prime factor in economically performing certain divisions of the work, such as drilling and riveting, and has indicated the necessity for air-compressing outfits of thorough efficiency and rugged construction. The air compressor herewith illustrated is a National Type "E-1" portable outfit, manufactured by the National Brake & Electric Company, Milwaukee, Wis. This type of compressor is well adapted for service in boiler shops and for outside work, where the available space is limited or the nature of the work requires that a supply of compressed air be delivered in different places and under constantly changing conditions. Its installation affords extreme flexibility, as the outfit can be easily hauled from place to place and operated at whatever point it is desired to apply the power. No extensive piping is required, and it is claimed that the cost of maintaining the system is surprisingly low.

The outfit consists of a motor compressor, reservoir and accessories, mounted on a specially built steel truck, with steel wheels and axles. Surmounting the outfit is a galvanized iron pan that provides a suitable receptacle for a length of hose



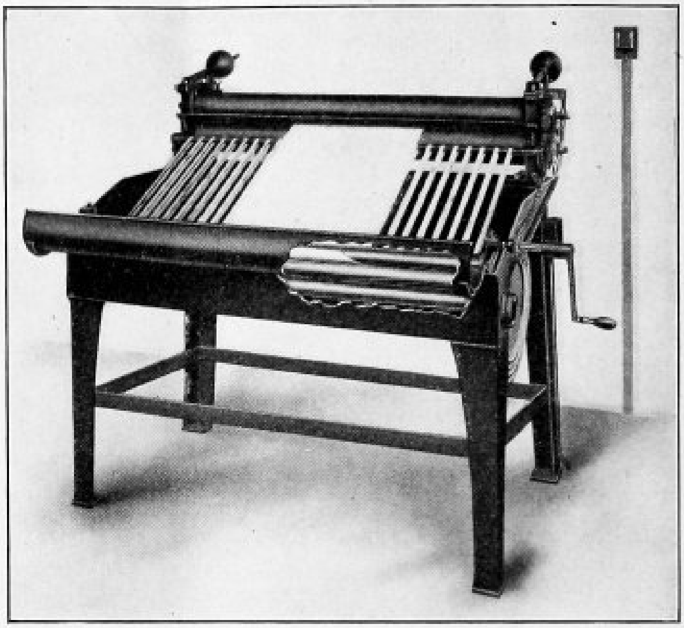
which serves to conduct the compressed air from the reservoir to the place of delivery. Type "E-1" portable outfit, with a capacity of 50 cubic feet of free air per minute, is equipped with a direct-current motor of standard design and has water-jacketed cylinder and valve heads to adapt it to continuous service. The outfit is also equipped with a radiator type of cooler, thereby providing for a free circulation of water around the cylinders and valve heads, keeping these parts at a minimum temperature.

In order to maintain the air pressure automatically within certain limits, the compressor is provided with an automatic controlling device, by means of which the compressor is started and stopped when the air supply has reached a fixed minimum or maximum pressure. The outfit complete, piped and wired, ready for instant service, includes a motor compressor, steel truck, suction strainer, automatic governor, mica insulator for motor compressor, mica insulator for automatic governor, air receiver, drain and stop cocks, pop safety valves, single-hand gage, single-throw, double-pole knife switch and fuse, hose pan and flexible hose connections, with a pair of couplings.

The Mechanigraph.

The Mechanigraph is a machine which has just been placed on the market by Topping Brothers, 122 Chambers street, New York, which makes transparent and printable an opaque pencil or pen drawing at slight cost, thus enabling blue prints to be made from original drawings without the necessity of making tracings.

The machine consists merely of a series of electrically-warmed rolls; a chemical bath, also electrically warmed from the wire that warms the rolls; a series of traveling tapes, and a pair of drier rolls. The whole machine, when set up ready to work, occupies a floor space less than 4 feet square. The operation consists merely in turning on the electric current, warming the rolls and bath, inserting the drawing, turning the



crank and thereby running the drawing through the rolls, which press the chemical fluid into the drawing as it passes through. On leaving the rolls the drawing is conveyed by the traveling tapes to a pair of drier rolls, where the surplus chemical is absorbed by surfacing paper inserted between the rolls. The drawing, therefore, comes from the machine practically dry, ready to be used for blue printing.

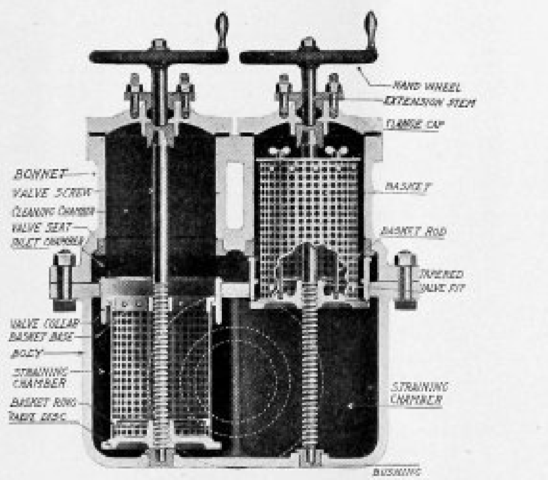
It is claimed that the mechanigraph makes any piece of white paper, no matter how heavy or opaque, transparent enough to blue print through quickly. The drawing may be made either in ink or pencil, as most convenient. It is claimed that there is no distortion or possibility of slip anywhere in the machine, so that the drawings are exactly the same as before being subject to treatment.

A further use of the machine is found in treating old and damaged tracings, which, it is claimed, may be made as good as new by passing through the machine.

Multiple Strainers.

Nearly all sources of water supply, especially for circulating water, contain an immense amount of suspended matter, and while attempts are often made to remove this by placing a strainer around the suction pipe foot valve, this only transfers the source of trouble. The strainer soon becomes clogged and it is necessary to shut off the pumps while it is being cleaned. If the water is being used for condensers this means the loss of the vacuum and throwing an extra load upon the power equipment of the plant, and if there is no reserve power it means shutting down the plant. In order to get around these difficulties, the Lagonda Manufacturing Company of Springfield, Ohio, has recently perfected a multiple strainer for removing impurities in feed water, circulating water, etc. These strainers can be installed in any position, horizontal, vertical or inclined. They also have the advantage that they are made up of different sections, which can be cleaned, one at a time, without interrupting the flow of water.

The strainer consists of a cast iron body having a number of removable strainer baskets, the number depending upon the size of the line. As these baskets can be easily removed for cleaning without shutting down the pumps, the mesh is made very fine; they thus eliminate more foreign matter than any other type of strainer. The water enters through the inlet pipe, passes up to the top of the valve chamber, where it divides, going down through all of the baskets in multiple. When it is desired to clean the strainer, one of the baskets is drawn to the upper part of the chamber by turning the hand-wheel; at the same time the valve collar is forced tightly against the valve seat and the valve disc on the bottom of the basket seats on the valve collar. This is all done automatically and entirely shuts off the water supply from the



section containing the basket to be cleaned. By means of a small bypass the pressure in this chamber is now relieved and the bolts at the top loosened and the flange cap tilted over, exposing the basket. The basket can now be taken out and cleaned. In replacing the basket the operations are exactly the reverse. The next basket can now be removed in the same way and the whole strainer cleaned without shutting off the water. Should an obstruction rest upon the top valve collar, the basket, when raised to cleaning position, will have a tendency to tilt the obstruction either into the basket or out of the way of the valve. This is due to the fact that the basket travels nearly its entire distance before the lower valve disc comes into contact with the lower seat of the valve collar.

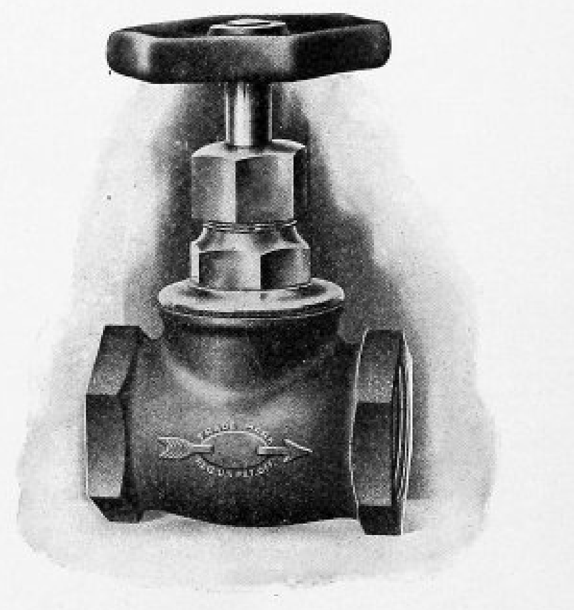
The effective straining area of a Lagonda Strainer is from 2¼ to 4 times the area of the pipe line, and in removing one basket for cleaning the straining area is not reduced more than 30 percent; thus the pipe line is never throttled in the process of cleaning. In practice one of the baskets is left out of service, so that in case the baskets in use should become clogged the clean basket can be quickly lowered into service.

One important item concerning these strainers is that all of the internal parts subject to the action of water are made of bronze to eliminate troubles from corrosion. No leather or rubber washers are used.

Lagonda multiple strainers are built in sizes from 2 inches to 48 inches, having two to six baskets, the number depending upon the size of the strainer. They are also suitable for use in either suction or pressure lines, and are built to stand working pressures up to 200 pounds per square inch.

A New High-Grade Valve.

Arrow bronze globe, angle and cross valves are a recent product placed on the market by the Star Brass Manufacturing Company, Boston, Mass., and this new valve is of standard weight, mechanically designed so as to be correct and of



full pipe size area. It is expressly designed to fulfil the existing want for a low-price standard weight valve, and is not made for competition with the so-called "competition" type of valves. These valves are carefully made of the best steam metal, all parts being interchangeable. It is made in three styles, globe, angle and cross, with screw ends. Each valve is tested to 300 pounds per square inch hydrostatic pressure before shipment.

SELECTED BOILER PATENTS.

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

LOAN AND TRUST BUILDING,

Washington, D. C.

Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

961,522. BOILER BRACE. CHARLES NEBLETT, OF BELLEVUE, KY.

Claim.—A boiler brace having a body portion formed from a single piece of sheet metal doubled over middle length, and having a partial twist intermediate its ends, a head attaching member having laterally extending feet arranged at right angles to a part of the body portion, the laterally bent portion of the feet then being bent back upon themselves and terminating into inwardly arranged projections, said projections being flush with a part of the body portion for a certain distance of its length. One claim.

962,322. STOKER MECHANISM. PAUL L. CROWE, OF JERSEY CITY, N. J.

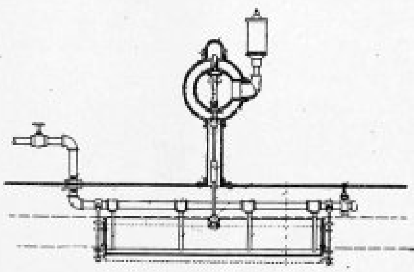
Claim 2.—The combination with a furnace having a grate surface and an ignition arch above the grate surface, of skewbacks mounted at the sides of the furnace and extending the depth of the arch, said arch comprising keyed blocks the depth of the arch, all self-supporting upon and between the skewbacks and forming a continuous plain under surface throughout the transverse extent of the arch, a member arranged transversely of the outer face of the arch, and retaining means connecting each of the blocks with such transverse member. Four claims.

962,454. WATER-TUBE BOILER. SIGNONO C. MUNOZ, OF MONTCLAIR, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 2.—In a water-tube boiler, the combination with inclined heating tubes, of an upper drum on each side of the heating tubes, a mud drum on each side of the heating tubes, a U-shaped drum beneath the lower ends of the heating tubes, headers at said ends of the heating tubes communicating at the bottom with the U-shaped drum, and side tubes exposed to the heat of the furnace on each side of the boiler some of which connect the upper drums and the U-shaped drum, and others of which connect the upper drum and the mud drum. Three claims.

963,028. BOILER-ALARM. ALEXANDER J. ADERHOLD, OF BIRMINGHAM, ALA.

Claim 3.—An apparatus comprising in combination with a boiler, a float disposed within the boiler and having an opening through which



water can overflow into the float, a valve controlled pipe leading from within the float to a point outside of the boiler, and indicating means operated by the float. Ten claims.

964,916. BOILER-FEEDER. AUGUST JUNGER, OF METZ, GERMANY.

Claim 2.—In an automatic boiler-feeding apparatus, the combination of an open float normally displacing a substantially constant and predetermined volume of its supporting liquid, a steam pipe and a controlling valve therefor, both inclosed by said float, said float having guiding devices operating to permit of its movement along a predetermined path, the controlling valve aforesaid being actuated by the movement of said float. Four claims.

965,292. BOILER-FURNACE. GUSTV DE GRAHL, OF WILMERSDORF, NEAR BERLIN, GERMANY.

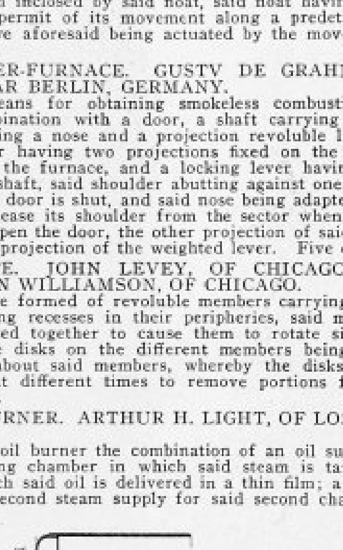
Claim 1.—In means for obtaining smokeless combustion in boiler furnaces, the combination with a door, a shaft carrying said door, a weighted lever having a nose and a projection revoluble loosely on the door-shaft, a sector having two projections fixed on the door-shaft, a shaft revoluble on the furnace, and a locking lever having a shoulder fixed on the latter shaft, said shoulder abutting against one projection of the sector when the door is shut, and said nose being adapted to raise the latter lever and release its shoulder from the sector when the weighted lever is rotated to open the door, the other projection of said sector being then driven by the projection of the weighted lever. Five claims.

965,589. GRATE. JOHN LEVEY, OF CHICAGO, ILL., ASSIGNOR TO JOHN WILLIAMSON, OF CHICAGO.

Claim 1.—A grate formed of revoluble members carrying disks spaced apart and containing recesses in their peripheries, said members being operatively connected together to cause them to rotate simultaneously, the recesses in the disks on the different members being disposed in varying positions about said members, whereby the disks on different members operate at different times to remove portions from the fire-bed. Three claims.

965,719. OIL-BURNER. ARTHUR H. LIGHT, OF LOS ANGELES, CAL.

Claim 1.—In an oil burner the combination of an oil supply; a steam supply; an atomizing chamber in which said steam is tangentially delivered and in which said oil is delivered in a thin film; a second atomizing chamber; a second steam supply for said second chamber; a con-



nection between said chambers; a pipe leading from said second chamber to the furnace; and automatic means for controlling the amount of oil delivered to said first-mentioned chamber by the pressure of the steam generated by said furnace. Ten claims.

966,051. FLUE-CLEANER. ELZA H. REITER, OF ELGIN, ILL.

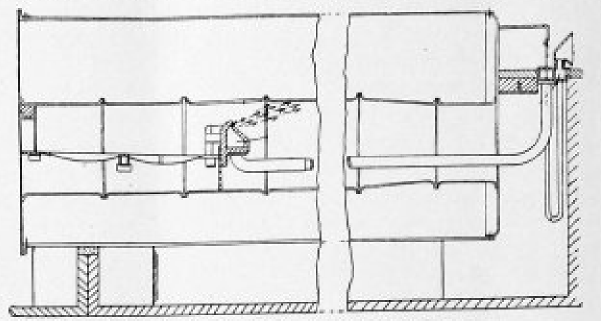
Claim 2.—In a boiler flue cleaner a stationary supporting member, a transverse member carried by said supporting member and provided with a transverse aperture, a pipe extending through said aperture, a supporting frame mounted to swing from said stationary supporting member in position to be engaged by said pipe, and means for adjusting said swinging frame vertically. Six claims.

967,927. FURNACE DOOR. CARL J. F. JOHNSON, OF CLEVELAND, OHIO.

Claim 2.—A hollow furnace door consisting of a body having a rim about the same and inner and outer plates fixed at their edges to said rim, said body dividing the door into front and rear chambers, bolts connecting said inner plate with said body at intervals over its middle portion and air conducting tubes connecting said plate about its edge with said body, said bolts and tubes being alike screwed into said inner plate and secured by nuts to said body. Five claims.

966,109. SMOKE-CONSUMING APPARATUS. WILLIAM RAMSAY MARSHALL, OF OLDHAM, AND THOMAS HARGREAVES, OF ASHTON-UNDER-LYNE, ENGLAND, ASSIGNORS TO VICTORY SMOKE CONSUMER AND FUEL ECONOMIZER COMPANY, LIMITED, OF OLDHAM, ENGLAND.

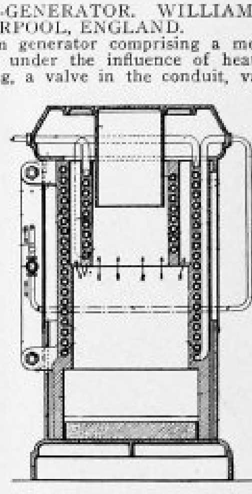
Claim.—The combination with a furnace and boiler, said furnace having a hollow bridge and a passage for the products of combustion, and a pair of headers, of a series of pipes or tubes at one end of the boiler and located in said passage, said tubes at one end being connected by one of said headers and at the other end by the other header, an air inlet leading to one header, a pipe connecting the other header



with said hollow bridge, the capacity of said series of pipes and the inlet thereto being less than the capacity of the pipe which connects with the hollow bridge, and a steam pipe leading through one header and into the pipe which connects that header with the hollow bridge. One claim.

966,201. STEAM-GENERATOR. WILLIAM GEORGE HAY, OF TUEBROOK, LIVERPOOL, ENGLAND.

Claim 2.—A steam generator comprising a metal casing, adapted to contract and expand under the influence of heat, a conduit connected with the metal casing, a valve in the conduit, valve controlling means



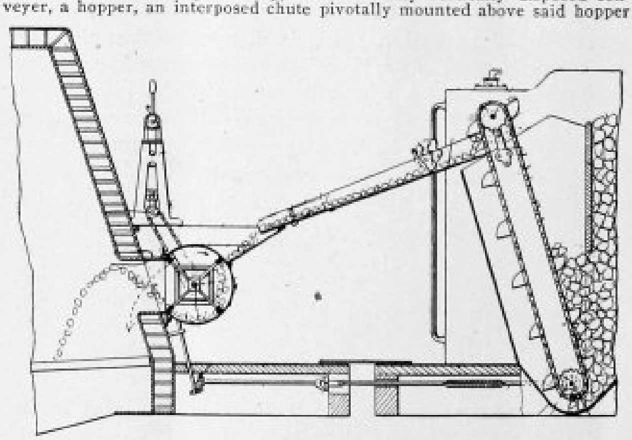
including two spaced apart members connected with the casing at spaced apart points and adapted to operate the valve to control the flow of water through the conduit. Ten claims.

966,233. FURNACE. CARL NORDELL, OF STAMFORD, CONN.

Claim.—In a furnace, the combination of a hollow grate bar having an inlet at its front end and lower edge, and an outlet near the rear part thereof, said bar having a slot in its upper surface near said rear outlet, and a detachable air distributer adapted to form a continuation of said rear outlet, said air distributer having lugs upon its lower edge, one of said lugs being adapted to hook beneath the top surface of said bar and the other lug to fit said slot and be detachably held in place therein. One claim.

966,547. MECHANICAL STOKER. DAVID F. HERVEY, OF LOGANSPORT, IND.

Claim 26.—In a mechanical stoker, the combination of a furnace having a fire door opening, a fire door for said opening hinged to the furnace front to swing laterally, a substantially vertically disposed conveyer, a hopper, an interposed chute pivotally mounted above said hopper



with its free end slidingly supported on the hopper, a distributer casing, and a rotary distributer carried thereby to swing upwardly against the furnace front when the fire door is opened, whereby the same may be moved to allow of hand firing, and means for continuously rotating the distributer. Twenty-nine claims.

THE BOILER MAKER

NOVEMBER, 1910

OXY-ACETYLENE WELDING.

BY J. F. SPRINGER.

In what is properly known as welding, it is not necessary that any part of the metal involved shall reach the fusion point. However, the recent processes of autogenous welding demand the absolute liquefaction of material. They are, in fact, not welding processes at all, but methods of localized casting. Thus, to unite two pieces of sheet metal by ordinary welding, we heat to a high temperature, at which the metal is more or less plastic, and then by hammering, or mechanical pressure otherwise applied, we secure a molecular union of the surfaces. Whether the joint is a lap or a butt weld, an excess of material is required. This comes from the work itself. With such a method, however, as the oxy-acetylene process of the Davis-Bournonville Company, New York, all this is much changed. No pressure is required to effect the union. The temperature is such that the bulk of the material involved in the finished joint is actually melted, and provision for an excess of material does not have to be made. We have thus two advantages to balance against a single one. All that is necessary, in order to dispense with pressure and excess of metal, is to provide a controllable means of securing high temperatures locally. Indeed, there is an additional advantage which is often available—the material to be united need not be weldable metal, such as wrought iron and low carbon steel.

But the high temperature in a controllable form is an essential. It is interesting to see, then, just how it is secured by the Davis-Bournonville torch. Acetylene is an explosive gas, consisting of equal volumes of carbon and hydrogen (C_2H_2). When it disintegrates—or explodes—heat is liberated. The hydrogen set free may be burnt to water (H_2O) and additional heat thus be obtained. The carbon may burn to carbon monoxide (CO); or, if sufficient oxygen be present, to carbon dioxide (CO_2). In both cases more heat is evolved. The total heat possible from the one explosion and the three processes of combustion is 21,850 British thermal units[1]—one pound of acetylene gas being involved. But the torch is so designed and the flow of gases so managed that the welding flame proper is the scene of only a portion of the heat evolution. This flame is very small, having a length, varying with different tips, from, say, 2/5 inch to 9/16 inch in length, and having a diameter of about one-third the length. This space has a volume varying from .0056 cubic inch to .0156 cubic inch. Within it, however, two of the four processes, at least, are supposed to take place. Here we suppose the explosion of the acetylene occurs and the combustion of the carbon (thus set free) to carbon monoxide. This flame is brilliantly white. This indicates that little or none of the carbon monoxide is further consumed to carbon

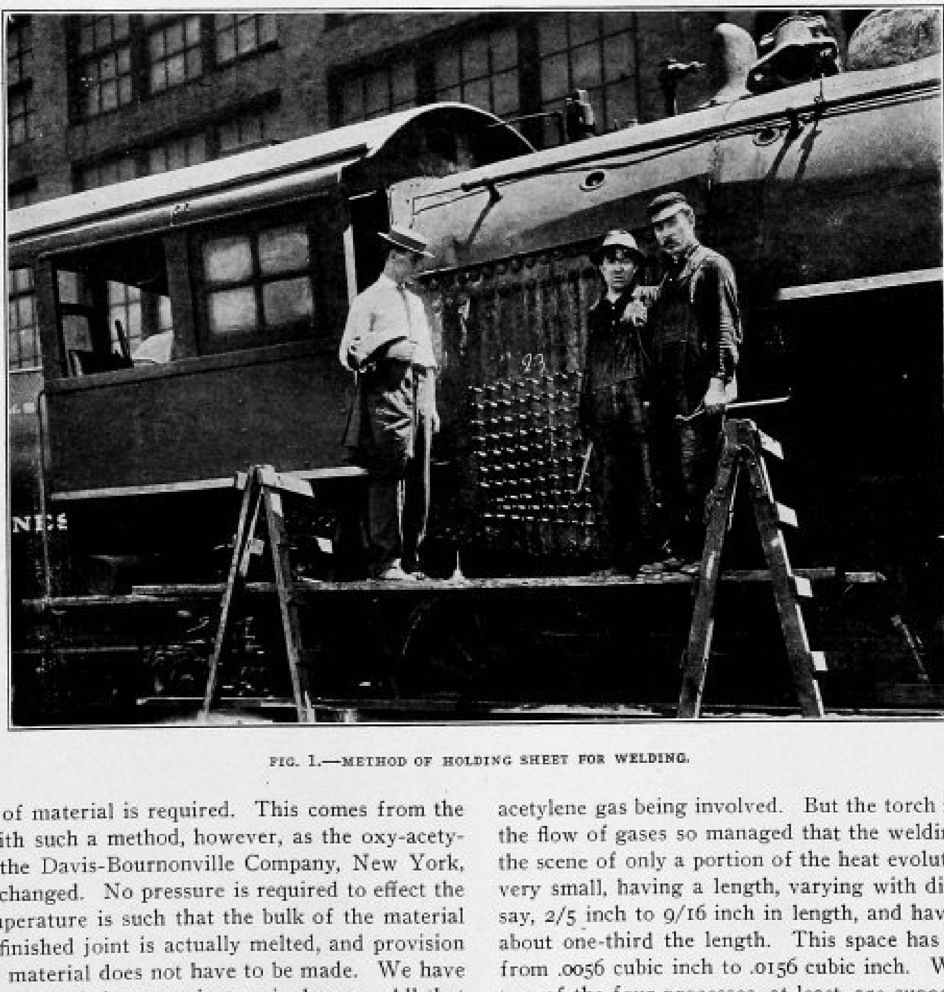


FIG. 1.—METHOD OF HOLDING SHEET FOR WELDING.

[1] A British thermal unit (B. T. U.) is the quantity of heat required to raise the temperature of 1 pound of water 1 degree F.

dioxide, as this combustion is attended by a bluish flame. The whiteness is due, no doubt, to incandescent free carbon. In so far as a total of heat units is concerned, only about one-third is produced here in the little inner flame (7,758). But—and this is a point demanding strong emphasis—the 35½ percent of the heat units are concentrated in what is comparatively a very minute space. And so incredibly fast does dissociation of acetylene and combustion of carbon to the monoxide take

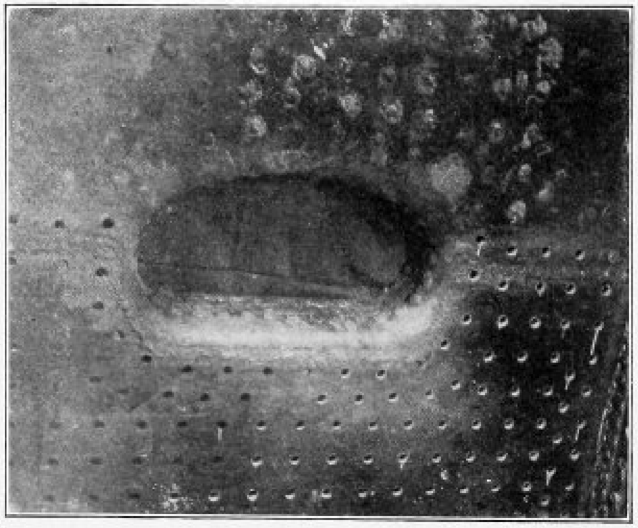


FIG. 2.—WELDED DOOR SHEET.

place that both are accomplished in a minute interval of time —unbelievably minute, in fact. Further, not only is there the very strong concentration within the confines of the little flame of a large part of the total heat evolved from complete combustion of the acetylene, but because of the onward rush of the gases there is a further concentration at or near its tip, or outer end. It would seem as if pretty much all the heat of the little flame must pass this point. When all considerations are taken into account, it is perhaps not to be wondered at that the oxy-acetylene torch is said to have a localized temperature of about 6,000 degrees F.

With this style of apparatus both oxygen and acetylene are furnished mixed at the nose of the tip in the proportions of 1.28 to 1. The proportion of oxygen is insufficient to burn the carbon to the dioxide and the hydrogen to water. For that purpose 2.50 volumes of oxygen are required. Thus complete combustion is hindered. It occurs ultimately, when the surrounding air has supplied the remaining 1.22 volumes of oxygen. There is, however, more than enough oxygen coming from the tip to burn the carbon to the monoxide. It has been found from actual practice that some excess is necessary. The reason for this is probably because the mixing of the acetylene and oxygen in the main chamber of the tip is not, and perhaps cannot be, absolutely perfect. The excess of 28 percent seems to be just right. If somewhat more oxygen is supplied, the work suffers from oxidation; if less, it is carbonized. For the best results, it is very necessary that the ratio be maintained.

Now it is such excessive temperatures as this that make localized casting possible. The capability of steel and other metals to absorb, conduct away, and otherwise dissipate heat is so great that a flame must ordinarily be excessively hot to bring the metal to a moderate heat. Nobody wants to heat steel to 6000 degrees F., but such temperatures of the gaseous flame are necessary in order to heat the metal to the fusion point. Wrought iron melts at about 2,700 degrees; steel at a lower temperature. But when we are applying a gaseous stream of 2 or 2½ times the temperature we are not, perhaps, going a whit beyond what is really essential for the best results.

Those who have given attention to the oxy-acetylene process will remember, perhaps, that in uniting two edges they are first prepared by chamfering each. The sides of the V-groove thus produced are heated, a part at a time, to a plastic condition and absolutely fresh metal melted in to fill up the bulk of the groove. The plastic surface affords a possibility of attachment—molecular attachment—for the freshly cast material. Now, in practice, it has been found that, with heavy work, conduction and radiation operate so rapidly as to make it difficult to heat the sides of the groove to a sufficiently high temperature. To meet this difficulty, it is customary to preheat the work in the vicinity of the groove. The activity of the flame can then be more advantageously concentrated upon its proper work. A little reflection, however, will soon convince one that the employment of large volumes of heat at local points will introduce problems of expansion and contraction. The coefficient of expansion for mild steel is about .0000066 for 1 degree F. If a steel rule be so heated that a certain one of the inches is 200 degrees hotter than the adjacent ones, then that inch occupies 1.00132 inches of space. It will readily be seen then that, if it should be mechanically confined, serious stresses may be set up. Sometimes the form of the work is such that relief is obtained by expansion in other directions. Ideally, what should be the case with a piece of work highly heated locally is that the temperatures should grade off gradually away from the center of heat, and the whole area involved should be large. In this way there will be no violent changes—one part will not be excessively expanded beyond adjacent parts. The great expansion of the central part will grade off by degrees to normal unexpanded regions. Of course, the total expansion involved over the whole heated portion may be considerable. The operator must use his judgment to determine in advance whether the form is such as to permit a readjustment of pressures in other

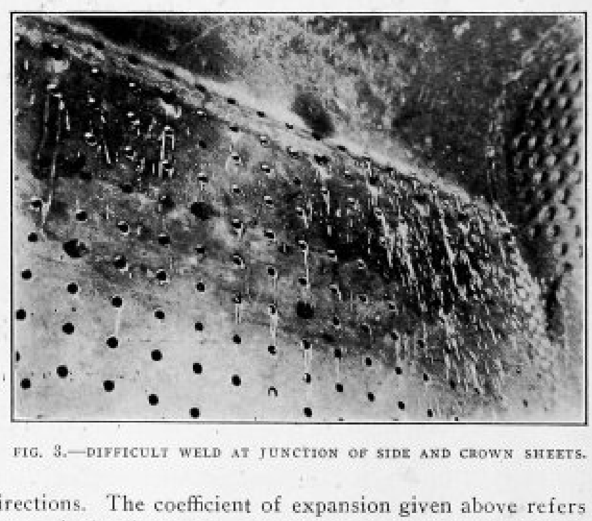


FIG. 3.—DIFFICULT WELD AT JUNCTION OF SIDE AND CROWN SHEETS.

directions. The coefficient of expansion given above refers to but a single dimension. If a body is entirely unconfined, it has three directions in which to find relief. If confined along two dimensions, its opportunity is cut down. If confined every way, it should not be heated above its surroundings. Consider the edge of a piece of heavy sheet metal. Practically this strip is confined in but one direction. It can expand in the direction of the length of the sheet. It can also expand above and below. But transversely, it is held by the cooler metal to which it is attached. A plate 30 inches wide would increase .4 inch with the temperature raised 2,000 degrees F. This would be resisted strongly by the cool metal.

We should expect, consequently, that some of this expansion would manifest itself in the other directions. But suppose now that we limit the longitudinal movement of the sheet and vertical expansion in thickness—I should expect very serious stresses and strains. If actual breakage does not result, this can only be attributed to the plasticity of the highly heated metal.

Similar remarks may be made in connection with cooling. Sharp boundaries separating areas of different contraction are to be avoided. Contraction tends to take place in all directions. We should seek to permit this to go on with as little hindrance as possible. If hindered to the extent that the total contraction can not be accommodated in some one or two directions, then we may expect cracking. Now any system of localized casting has to deal with such considerations as have been outlined.

Consider for a moment the metal in the groove itself. This has been brought to the point of fusion and so will undergo a tremendous amount of contraction in returning to normal temperature. Except for the layer brought to a semi-fluid or plastic condition, the adjacent material has fallen far short of the fusion point, and so will contract far less. We are to expect then that the new material in the groove will shrink away from the old, the plastic layer tending to accommodate the differential contraction. In some work the new material is added slowly and a good deal of the effects of contraction thus occur only little by little. In other cases it seems more desirable to make the whole union rapidly. The new material is then left alone and heat applied to the adjoining portions of the work. The effect of this is to reduce the differential contraction, or rather to delay it, and allow it to be accommodated. For this subsequent heating the torch itself is well adapted. The outer flame is quite hot, being the scene of the combustion of hydrogen and carbon monoxide.

In the application of local casting to boiler work the effects of contraction and expansion constitute one of the serious problems. We can not expect this entire question to be settled at once. Progress is being made and standard practice is being determined along certain lines. Other lines have problems that have not been fully solved. The thing for the practical shop is to employ the system for precisely that class of work where the proper procedure has been discovered and proved, and to go cautiously where practice is not yet settled.

Another question which is important to the boiler maker is the character of the metal involved. The heating of steel to high temperatures results, if the metal is allowed to cool undisturbed, in a comparatively large grain. The higher the heat the larger the grain. This is the general rule. Such large-grained material is weak. Fortunately, however, there are methods of restoration. One of these effects its results by a reheating of the metal. When the temperature has arrived at a certain point the large grains begin to break up and new small grains are formed. If the reheating is so managed as to accomplish this result through the whole of the mass involved, then we have restored our steel, provided we now check the rise of temperature. If we allowed the temperature to go on up, the grains would become larger and larger. The difficulty here consists in bringing the whole to the desired temperature at one time, so that when the heat is stopped we may have uniform results. To accomplish this, one way is to heat up very slowly, keeping all parts within a few degrees of each other. There is another method of restoration—mechanical treatment. Large grains may be broken up by hammer blows and the like. If this is done, at the proper temperature, the whole mass involved assumes a fine compact grain. It will readily be understood, then, that a skillful operator may handle his hammer to advantage during the process of effecting a weld. There are low temperatures where hammering would probably be detrimental. He must know this and avoid breaking up the grain when it will not re-form properly. It must be borne in mind that the effect of a blow has but little real penetration. On the whole, it would seem well to employ the hammer continuously and thoroughly, but not to rely upon it entirely. There are situations when the metal has been highly heated and the grain made large where the effects of the hammer will never reach. Reheating should be employed wherever practicable. Heat penetrates pretty much everywhere. The proof of the possibilities is the subjection of sample pieces to tensile and other tests.

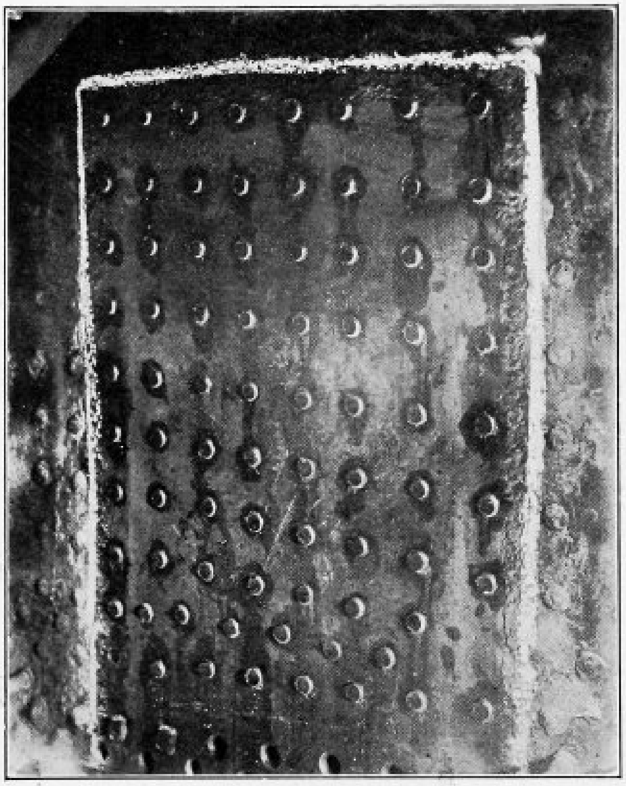


FIG. 4.—WELDED SIDE SHEET.

That the oxy-acetylene torch is capable of effective boiler work is well shown by examples of actual work. Cracks in crown sheets have been successfully welded, and mention may be made of the case of locomotives on an Eastern railway. Four engines employed on a road in the Middle West had repairs of cracks in the crown sheets and in the bridges between the flues in the flue sheets. These engines have gone into actual service, and successfully, to judge from a recent report of the matter. A 15-inch crack developed in the crown sheet of a boiler on an ocean-going steamship. An oxy-acetylene operator filled up the crack acceptably to the steamship company. This instance was on the Atlantic Coast. Still more recently an instance of the successful repair of a 14-inch boiler crack occurred on the Pacific Coast. The steamer was the *A. W. Sterrett* and the repair was made at the plant of the Nickerson-MacFarlane Machinery Company, Tacoma. From a large railway shop, where the oxy-acetylene process has a place, a welder reports that he has engines running where there are "over 40 lineal feet of welding in all parts of fireboxes and boilers."

In certain refrigeration apparatus a manifold of 5 inches in diameter is used. Upon this are secured sixteen 2-inch flanged steel nozzles. These are welded on, whereupon the test of a hydraulic pressure of 500 pounds per square inch is applied. The concern doing this class of work with the oxy-acetylene torch is a prominent one in Philadelphia. They state that they "are able to weld the manifold in long sections, in any number and size of outlets, without the use of intermediate joints. . . . By this method we are able to eliminate all kinds of fittings with sweated and soldered joints to cut down the weight of such manifolds and do away with all possibility of leakage." It will be noticed that while this work is not to be subjected ultimately to steam pressure, still it is severely tested. In the manufacture of pipes themselves the butt welding of the longitudinal joint has been accomplished, thus replacing riveting. Steel sheets of about 3/8 inch thickness are used and pipes having a diameter of 5 to 7 inches made. To these cast steel flanges have been successfully attached by the same methods. In fact, such pipes with flanges and risers have been made thus to be practically one single piece of metal. A test of 1,000 pounds per square inch is applied, and, as a rule, is successfully withstood the first time it is applied.

The Bibb Manufacturing Company, Macon, Ga., have two Hawley Down Draft Boilers totaling about 110 horsepower. One of the headers, a tube of about 8 inches diameter and having a wall of 1/4 inch thickness, developed a crack, which was plugged. But the plug opened the crack for a length of 3½ inches, and in fact started another one two inches long. In ten days they could have gotten a new header and put it in place in a reasonable time. But the plant would have had to shut down. The oxy-acetylene torch, however, dealt with the cracks in a few minutes' time after the operator was on the spot.

A number of test bars were recently welded by this process. Upon applying tensile tests, an average resistance of about 49,000 pounds was disclosed.

Upon referring to Fig. 2, a view of portions of the two halves of the door sheet to a passenger locomotive fire-box will be seen. I am not permitted to give the name of the railroad. This engine is rated as carrying 200 pounds pressure. By means of a Davis-Bournonville outfit a very considerable weld was effected here. This may be traced clear across the view. Beginning on the left, half way between top and bottom, it runs horizontally to a point between two stay-bolt holes, where it dips down by a straight line to continue horizontally across, just above a row of stay-bolt holes. It completes its journey by rising at an angle and then running horizontally to the right-hand edge. The problem in effecting such welds turns largely on caring for expansion and contraction. The sheets are partially confined, so that skill and attention are necessary. In Fig. 3 we have a view of the region of the junctions of a side sheet with the crown sheet of the fire-box and with the boiler ends. This view is from a very heavy freight engine which carries 200 pounds pressure. Two full side sheets are welded in. This engine was repaired by the same railway company. The operator writes: "We have several engines in service with from 30 to 44 lineal feet of welding and not one has so far shown any signs of defects or weakness. I now (April 23, 1910) have over 400 different welds in service and all are the talk of the road men. Nothing is any good unless it is welded." All of this shows that though skill may be necessary, it is possible to acquire it.

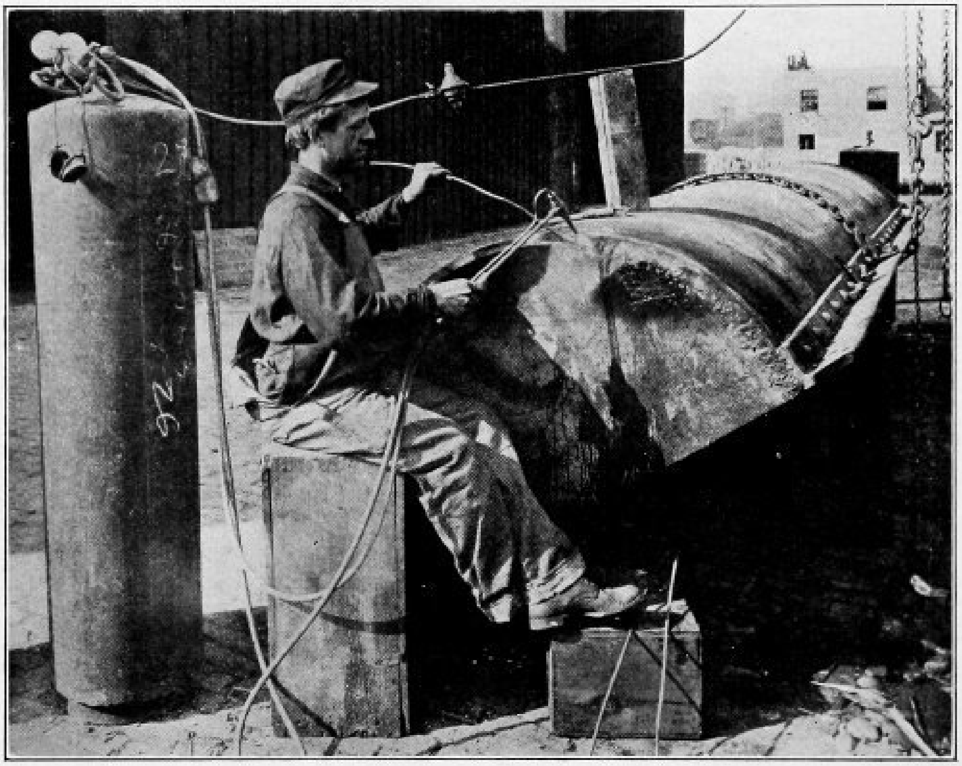


FIG. 5.—A HEAVY TANK SUCCESSFULLY WELDED BY THE OXYACETYLENE PROCESS.

On the Santa Fe Railroad tests have recently been carried out in connection with the use of the Jacobs superheater. From a constructional point of view these two-stage superheaters are much like tubular boilers. It seems that the process employed for attaching the superheater tubes to the sheets is by oxy-acetylene welding.

In Fig. 1 we have another example of fire-box repair. The engine belongs to a railway in the Middle West and the view is taken at the car shops. The part welded corresponds to the area shown on the exterior, where the projecting rods are seen. These are for the purpose of holding the portion of sheet to be welded on to its proper position on the interior. In Fig. 4 we have an interior view of the fire-box. The line running up and across and down again indicates the location of the weld itself. It is easy to see that the length of weld involved is considerable. The railway is one of the principal ones in its section, and in fact forms part of one of the greatest systems in the world. The fact that this road is doing work of this character speaks for itself.

In Fig. 5 we have an example of an application of oxy-acetylene welding to a case involving severe requirements. In the first place the sheet metal is very heavy. Secondly, the tank when completed becomes the heating tank for a metallurgical operation. There are thus very considerable expansions and contractions to be repeatedly undergone by the welds and the adjacent material in the ordinary service to which the tank is put. For this severe service the welded tank has been found superior to the riveted one. The tank back of the operator contains oxygen. It is permissible to use a portable reservoir for it, but scarcely for the acetylene. The latter gas is brought to hand by suitable tubing. A metal tube brings the supply in at the operator's left. The reduction valve may be seen to the left and to the front of the workman, mounted on the metal tube. A flexible tube carries the acetylene to the torch itself. It is considered quite a dangerous thing to make use of a portable generator of acetylene, as this gas is a very explosive one and an explosion might readily be precipitated by the accidental overturning of the generator. This danger does not attach to the oxygen. It is important, however, with oxygen under high pressure that all connections be very strong and especially that no possibilities of leakage can occur. A leak once started might have very serious results, the oxygen cutting its way out.

If a concern uses acetylene at a number of points in its shop, a very good way is to make use of a supply pipe carrying the gas at the maximum pressure used. It can then be supplied to the several working points.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.

Proceedings of the Twenty-Second Annual Convention.

The twenty-second annual convention of the American Boiler Manufacturers' Association was held at the Auditorium Hotel, Chicago, Ill., on Oct. 10, 11, 12 and 13, 1910, Wednesday being devoted to a visit to Gary, and the remaining days occupied by the convention sessions.

The Illinois Steel Company very kindly tendered a special train of Pullman cars for the trip to Gary, and the mammoth steel plant was inspected in the forenoon and the town of Gary in the afternoon of Wednesday, a noon-day luncheon being served on the Pullman cars. Other courtesies were: Visit to the Art Institute for the ladies; reception, dance and vaudeville entertainment Tuesday night; automobile sight-seeing trip, shopping tour, theater party, luncheon at Lawndale, the latter being courtesy of Jos. T. Ryerson & Son; the final function being the annual banquet Thursday night.

Col. E. D. Meier called the convention to order, and presided throughout as president of the association. The address of welcome to the City of Chicago, in the absence of Mayor Busse, was made by Hon. George M. Bagby, assistant corporation counsel, who proved to be an entertaining talker, and delivered more than the usual stereotyped address, incidentally suggesting that the boiler manufacturers turn their hands to the task of abating the smoke nuisance which afflicts Chicago, St. Louis, Cincinnati, Pittsburg, etc.

In his response, Col. E. D. Meier conceded to Chicago everything of pre-eminence she claims, and in regard to the smoke abatement said that it is unfortunate that the cities named use a fuel which not only contains more smoke to the pound, but requires by reason of its lesser content of British thermal units more pounds to be burned under the boilers to produce the same efficiency than the coal used in the Eastern sections of the country. Among other compliments which Col. Meier paid the Chicagoans was one to their spirit of progressiveness and their loyalty to their city and co-operation in all endeavors to advance its business and other interests.

After the address of welcome and response, the convention went into executive session for the remainder of the morning, adjourning until afternoon, when the open session was resumed. The following were admitted to membership: G. A. Schust, Ft. Wayne, Ind.; Wholey Boiler Works, Providence, R. I.; F. G. Fernstrum, Menominee Boiler Works, Menominee, Mich.; John Nooter Boiler Works Company, St. Louis, Mo.; Missouri Boiler Works Company, Kansas City, Mo.

Among the visitors and guests of honor at the convention

MEMBERS AND GUESTS OF THE BOILER MANUFACTURERS' ASSOCIATION IN CONVENTION AT CHICAGO, ILL.

were Gen. George Uhler, Supervising Inspector-General Steamboat Inspection Service, Washington, D. C.; Joseph McNeill, Chief Inspector and Chairman Board of Boiler Rules, Boston, Mass.; and Arthur E. Brown, a representative from the International Association of Master Boiler Makers, Louisville, Ky.; also Capt. Harold P. Norton, U. S. N. Mr. McNeill bore special credentials from Hon. Eben S. Draper, Governor of Massachusetts. A letter of regret was read from Mr. John A. Stevens, member of Massachusetts Board of Boiler Rules, representing the boiler using interests.

Mr. Andrew Jack, of Manistee, Mich., was introduced to the convention by Capt. Lappan as the oldest living boiler maker in the country. Capt. Jack displayed an old invoice, showing purchases by him of boiler plate at 9 cents a pound of Jos. T. Ryerson, Chicago, in November, 1868.

For the information of the convention, Mr. McNeill stated

COL. E. D. MEIER, PRESIDENT.
(Portrait from "Steam.")

that the Massachusetts Board of Boiler Rules is constituted as follows:

"The chief inspector of the boiler inspection department of the district police, who shall be its chairman; one member representing the boiler using interests; one member representing the boiler manufacturing interests; one member representing the boiler insurance interests, and one member who is an operating engineer."

Committees were appointed by the Chair as follows:

On Place Next Meeting.—Messrs. Ryan, Smith and Mackinnon.

Nominating Committee.—Jos. Wangler, Jas. Lappan, A. J. Schaff.

Auditing.—George N. Riley, Wm. Kehoe.

A communication was read from E. Leonard & Sons, London, Canada, urging the association to take steps looking toward the standardization of boilers. This was strongly supported by Mr. Ryan, of Duluth. It was generally conceded that standardization is becoming a necessity, just as it has been found to be in various other lines, such as in the railways, by pipe fitters, and even by the cotton manuafcturers, where certain standards are necessary in order to classify manufactured products. Messrs. Ryan, Ashley and Riley were named as a committee to investigate and report on this subject.

The chairman of the committee on topical questions made a report submitting a number of topics for discussion and stating that a number of others had been proposed, but as they had been discussed at various meetings some years ago the committee felt a hesitancy in again bringing them up. Among the topics presented by the committee and discussed were the following:

1. "If Boards or Commissions of Boiler Rules are created, should the majority of its members consist of engineers or boilermakers?"

This was fully discussed, and the main point brought out was that the men who are appointed as inspectors or as members of such boards or commissions shall have had practical experience with boilers and be otherwise thoroughly competent. Men who have had practical experience as boiler manufacturers will qualify for the duties on such boards more readily. The association members decided that they considered boiler manufacturers as better fitted to perform such duties than engineers who had not had practical knowledge of boilers, and that, in any event, the majority of the members of such boards or commissions should be practical boiler makers and engineers.

2. "Should the details of manufacture of boilers be regulated by such boards?" The reply was that necessarily such must be the case, and that it is one of necessities of our modern industrial system, that no matter how competent individuals may be we cannot leave the determination of these details to a number of competent individuals. The details must be fixed and standardized.

3. "Does any other line of manufacture specify so minutely the methods of workmanship and quality, quantity and locality of materials?" This again is a growing necessity of modern industrial conditions, and follows a necessary sequence from the establishment of certain standards which are considered in the previous question; and where it is not undertaken and carried out by government boards or commissions it is done by voluntary associations of manufacturers of the same class and type of goods.

4. "Does 'Public Safety' depend upon destroying the right of a manufacturer to build a good boiler in his own reputable way, knowing that it is the equal, at least, of a boiler prescribed by a commission?"

The above question was admitted, as were the prior ones, as illustrating a type of objections to the board or commission plan that have to be explained and met. It was satisfactorily answered by quoting from the Massachusetts Law, approved on May 14, 1909, as follows:

Section 26. . . . . "When a person desires to manufacture a special type of boiler the design of which is not covered by the rules formulated by the board of boiler rules, he shall submit drawings and specifications of such boiler to said board, which, if it approves, shall permit the construction of the same."

5. "What changes, if any, should be made in the Massachusetts Boiler Rules?"

After considering this question, the conclusion was that such inquiry can only be answered by any one who is interested in it bringing up specific questions. This association is not aware of any necessary changes, but is prepared to take up any special questions when they arise.

6. "Is it difficult to make calking tight where the bevel shear is used?"

It was generally agreed that it is not difficult to do so any more than with the use of planers, provided the material used is right, and the shears are kept sharp as they should be, and the work well laid out.

7. "Why do pneumatic-driven rivets leak?"

The answer was that they do not leak if proper care is taken. But trouble will occur when too much air is used in the rivet-heating fires, thereby causing undue formation of scale on the rivets, as previously fully explained in former discussions by this association on this head.

In the discussion of Question No. 5 above, Mr. Ashley said that last summer, when at Edmonton, in Alberta, making boiler drawings for his company (The Muskegon Boiler Works), he had occasion to discuss various provisions of the provincial boiler rules, as compared with some boiler rules on this side of the line, and the provincial boiler inspectors took exception to the Massachusetts boiler rules in the particular that they objected to giving a fixed distance from the flange of the head and from the top row of boiler tubes to the rear to be braced on the heads of horizontal tubular boilers, and their own rules give a formula for computing these distances, and they contended that it was not right to give fixed dimensions, as these respective distances would vary according to thickness of head used, the pressure for which boiler is to be constructed, etc. It seemed to Mr. Ashley that this point was well taken, as the distances in question can be expressed by a simple formula and computed easily, as, for instance, staybolt bracing, and that the Massachusetts rules would conform more to theory and be nearer correct in practice by having these dimensions computed for instead of giving fixed dimensions to cover all cases.

The convention then adjourned to Tuesday morning.

TUESDAY MORNING SESSION.

President Meier referred to the fact that some members had asked where they could get information relative to the various laws of cities and States throughout the United States governing boiler specifications and inspection, and he would refer such members to the columns of the BOILER MAKER, which had published a number of such ordinances. Mr. Slate, representing that magazine, stated that some two or three years ago the magazine had published practically all the rules of the States that were at that time available, but would be very glad to attempt to get more of them and invited members to correspond with his office regarding anything thev wanted in that line.

The Committee on Place of Next Meeting, 1911, through Mr. M. A. Ryan, chairman, reported favoring Boston, Mass., for the 1911 convention city and this report was unanimously approved and adopted.

The report of the Nominating Committee was submitted by its chairman, Mr. Jas. Lappan, recommending the re-election of present officers to serve for the ensuing year, which report was received and adopted and the officers re-elected as follows:

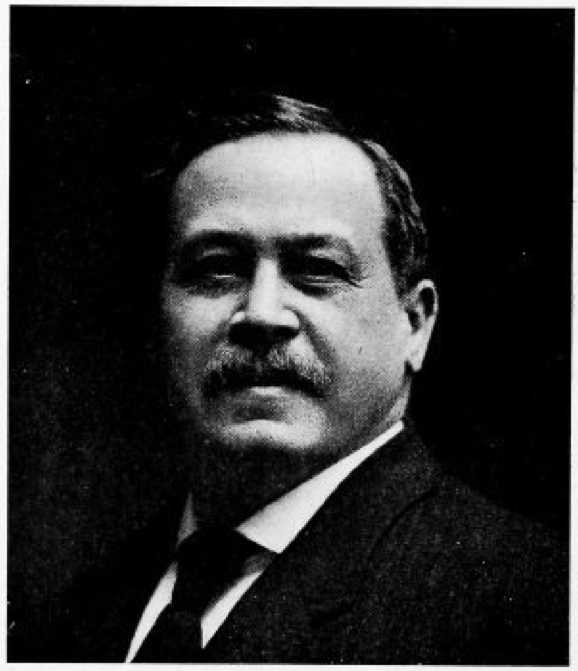
President, E. D. Meier, New York, N. Y.; secretary, J. D. Farasey, Cleveland, Ohio; treasurer, Jos. F. Wangler, St. Louis, Mo.; first vice-president, T. M. Rees, Pittsburg, Pa.; second vice-president, J. Don Smith, Charleston, S. C.; third vice-president, W. A. Brunner, Phillipsburg, N. J.; fourth vice-president, H. D. MacKinnon, Bay City, Mich.; fifth vice-president, M. A. Ryan, Duluth, Minn.

President-elect Meier and Secretary Farasey returned their acknowledgments for the evidence of confidence displayed by the members and appreciation of their labors.

A letter of regret was read from Mr. Richard Hammond, past president, of the Lake Erie Boiler Works, Buffalo, who was absent due to illness in his family.

Mr. Arthur E. Brown, special representative from the International Association of Master Boilermakers, was invited to address the convention and conveyed a message of greeting from his association, of which he is a past president. He briefly reviewed the progress of the boilermaking industry and the vastly increased efficiencies of the present as compared with past times, especially in locomotive boilers and marine boilers on the ocean liners, and reminded his hearers that the objects of the two associations, his own and the A. B. M. A., are kindred, inasmuch as both seek for the betterment of materials and processes and workmanship, and expressed the hope for a closer affiliation between the two bodies. His members had greatly enjoyed the remarks of President Meier at their Niagara Falls convention and only regretted that Mr. Main could not also have attended. He thanked the A. B. M. A. for other courtesies tendered by them and hoped that as many as could would attend the next meeting of his association, which is to be held at Omaha, Neb., unless a more central point is later selected.

A communication was read from Mr. George Riley recounting his attendance as an alternate at the last convention of the International Association of Master Boilermakers,

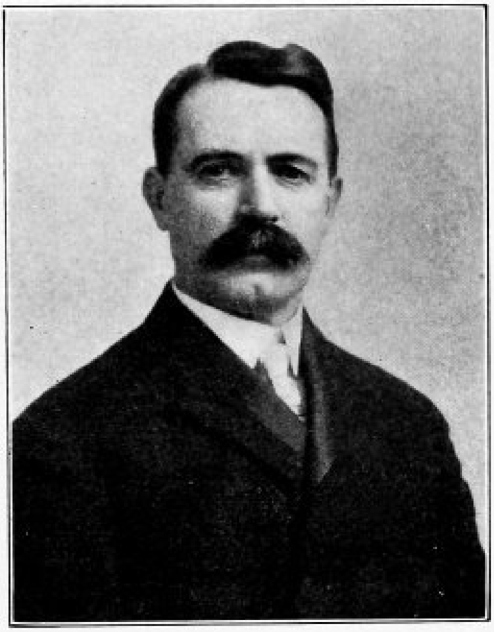


CAPT. T. M. REES, FIRST VICE-PRESIDENT.

and commending that association for the instructive and entertaining character of its proceedings and discussions.

Preceding the introduction of Capt. H. P. Norton, U. S. N., who later addressed the convention, a letter was read from Admiral H. I. Cone, Engineer-in-Chief, Bureau of Steam Engineering, Navy Department. President Meier introduced General George Uhler, Supervising Inspector General of the Steamboat Inspection Service, Department of Commerce and Labor, and referred to the unvarying courtesy with which General Uhler had always received representatives from the A. B. M. A., who had occasion to call upon him at Washington on matters of business coming before his department.

Upon taking the floor General Uhler said it was a great privilege and pleasure to be afforded the opportunity of again meeting with the American Boiler Manufacturers' Association and to hear the different discussions arising, because of all the vital questions coming before the Board of Supervising Inspectors of Steam Vessels, of which he is the president and chairman, none are so vitally important as the manufacture and the testing of materials employed in the construction of steam boilers. All such questions require full consideration and deliberation, often extending through days of time, and sometimes the board finds itself pretty evenly divided. Since the speaker had been a member of the board, now nearly nine years, it had always been his purpose and pleasure in the discussion of these questions that affect not only the safety of property but the lives of the people generally, as well as the convenience and the profit of the manufacturers, to call into the deliberations of the board those whom they feel know quite as much, and perhaps a little more, about the subject than the board. Some eight or nine years ago, when considerable trouble was being had with boiler plate, the board formulated specifications for boiler plate that met with considerable opposition on the part of the plate mills and considerable opposition on the part of dealers generally, they stating that the specifications could not be met. The speaker announced his intention to the board of inviting before them representatives of all the plate mills in this country to hear what they had to say on the subject of whether or not they could roll plate in accordance with the specifications that the board had prepared. The various representatives replied



J. D. FARASEY, SECRETARY.

when they appeared before the board at that time that they could meet the specifications, but it would cost more money, and with this statement before it the board stood by the specifications they had made, but it was not long after until complaints began to come in from boiler manufacturers that the mills were refusing orders for steel plate under the new specifications and new requirements from the fact that they said the specifications were so drastic and so restrictive that it was impossible to roll to them. The speaker found there was but one thing to do to protect the manufacturers and to protect the board and maintain the stand it had taken at that time, and that was to produce the answers that had been made to the inquiries that had been sent to the mills. Some of the gentlemen representing the mills said that they could make the plate, but it would cost more than the other formula. The speaker felt that the best plate that could be made was none too good when human life and property were at stake and felt sustained in his position. He believed that to-day the department is getting the best boiler plate that is made in the world in marine boilers, and he believed it is also the case with land boilers. He believed it is possible for the mills to meet strict specifications and roll good steel. With all precautions taken, of course some irregularities will creep in at times and perfection cannot ever be expected in human affairs, but the board had taken all reasonable precautions to get the best material. All matters are argued in the board where a difference of opinion exists among its members on any point, but when a decision is once arrived at by a majority of the board it is strictly adhered to, and when the ruling is approved by the secretary of the Department of Commerce and Labor it becomes the duty of the speaker to carry it out to the letter and no jot or tittle of it can be changed until the law is changed. General Uhler hoped it would be his pleasure to continue his attendance upon the meetings of the A. B. M. A.

Regarding the matter of relative merits of the spring pop safety valve and the lever type, the speaker said that while the board had held varying opinions on this subject, yet the majority of the board had decided that the old lever type safety valve is an efficient and satisfactory type of valve for smooth water practice.

In reply to an inquiry by Captain Rees, General Uhler said that according to existing law the only value that can be allowed to-day for a triple-riveted butt strap joint of whatever gage or thickness of material is the value that is allowed by that section of the law that provides that the triple-riveted joint shall be given twenty percent additional to the single-riveted joint, and you get no greater value for triple-riveted or quadruple-riveted than you do for double-riveted with the holes punched. This has been brought to the attention of the proper authorities, but will require an enactment by Congress before any change can be effected in the law. Until changed the board has no discretion in the matter, but must execute the law as it is. There had been in the past cases of ridiculous inconsistencies in the laws at times, but the remedy was not to sit down in a corner and pout about it, but come forward and by concerted and well-directed effort of an organized kind bring the matter before the proper authorities and have it corrected. This will do more than months and months of discussion when accompanied by lack of intelligent effort. General Uhler referred to the fact that Mr. Chas. Lukens had brought to the attention of the department the imperfect results arising from certain methods of testing by coupons taken from the edge of the plate, illustrating it by a diagram, which the board felt had given them valuable information, as it was most desirable to get accurate results as to the value of a plate. The speaker referred to the fact of his successful experience as an engineer upon the Atlantic for a period of nearly thirty years at one time, and acknowledged that his experience would not be worth much as applied to conditions on Western rivers, and commented on the different conditions that prevail in the various characters of service, on the Great Lakes, on the Western rivers, the Atlantic and so on. Of course, his connection with the department had given him a certain degree of familiarity with all, but his personal experience in earlier life had been upon the Atlantic. Whatever his personal opinion might be, however, on any matter he would always be governed by the majority rule in the board.

At the conclusion of General Uhler's remarks a unanimous and rising vote of thanks was tendered him on motion of Capt. T. M. Rees, of Pittsburg, for his courteous treatment of the A. B. M. A. committees at Washington and his attendance upon the convention and instructive remarks, and the hope was expressed that he might attend all similar conventions in the future.

In acknowledging this vote, General Uhler further adverted to the curious phase of the old law which required a plate manufacturer to stamp his plate with his name, place of business and the number of pounds of tensile strength that the plate would bear per square inch of sectional area; for years and years it had been the practice of the plate mills, no matter whether the plate had a value of 67,000 or 68,000 tensile strength, to stamp it at 60,000 as representing the lowest pressure for any plate entering into that boiler. The injustice of this rankled in the mind of the speaker and he wished to pay a deserved tribute to Col. Meier, that by his persistent efforts a change in this particular had finally been brought about, so that now the true tensile strength is stamped on every plate. He congratulated the members of the A. B. M. A. that every day governmental methods are improving and tending to the best modern practice, and a better and better spirit is pervading all administrative departments, and more and more respect is being paid to those who possess the technical skill and knowledge that pertains to their respective crafts.

President Meier now called attention to the fact that after the consummation of the joint agreement of December 15, 1905, between the American Steel Plate Association and the American Boiler Manufacturers' Association there had been manifested on occasions persistent activity on the part of individual mmebers of the Steel Plate Association, although not by the Steel Plate Association itself, which tended to devitalize that agreement, by such members making different specifications and arguing them, notably in the American Society of Testing Materials, resulting in the A. S. T. M. raising the limit of sulphur and phosphorus on flange steel. It had, therefore, by resolution of the A. B. M. A., adopted at Detroit, 1909, been determined to abrogate the agreement of December 15, 1905, relating to the percentage of sulphur and phosphorus in steel plates intended for use in steam boilers and return to the original A. B. M. A. Specifications of 1889, which fixes 0.03 percent maximum for sulphur and 0.04 percent maximum for phosphorus. Due to delay in receiving the official copy of the above resolution of the Detroit convention the American Steel Plate Association had not yet been notified of the abrogation of the December 15, 1895, agreement as referred to, but such action would now be taken. A letter of regret was read from Mr. Chas. M. Schwab at his inability to be present at the convention.

The discussion of Topical Questions, remaining over from the day previous, was now resumed.

The following Topical Questions relating to causes of boiler explosions were discussed, practically under one general head, by those members participating, namely:

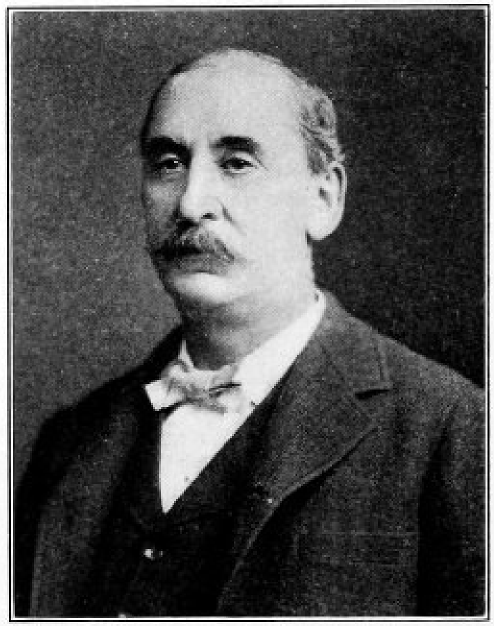
(1) Do you know of boilers having ruptured or exploded under fifteen years of service where the cause was due primarily to design, faulty material or poor workmanship?

(2) Are not the great majority of explosions (except where cause is fully known) due to frequent expansion and contraction in order to clean and repair extending over a period of more than fifteen years?

(3) Will not Rules for Inspection, proper methods of cooling, cleaning and re-heating boilers decrease explosions in a greater ratio than Rules for the Manufacture?

Mr. Wholey, of Providence, R. I., asked the Chair to call upon Mr. Joseph H. McNeill, Chief Inspector of the Boiler Inspection Department and Chairman Board of Boiler Rules of Massachusetts, saying that he thought Mr. McNeill had more actual knowledge of the matter of explosions than any man in the hall. Mr. McNeill stated that while in many cases the boiler explosions resulted from a combination of conditions, which included material, workmanship, operation, care and maintenance, yet there is no question but what individual cases of boiler explosions could be instanced which had resulted directly from faulty construction. He outlined as an illustration a case where the shell plate fractured at the longitudinal joint which was of double butt strap triple-riveted construction. The fracture in this case extended between the rivet holes in the outer row, and careful investigation showed that the shell of the boiler at the joint did not conform to a true circle; that is to say, the ends of the plate and the butt straps had not been properly formed to a true circle; also, the rivet holes had been punched almost full size, and in addition to the portion of the plate which fractured clear through incipient cracks were found at the rivet holes extending longitudinally with the boiler. In reply to the Question No. 2 above, Mr. McNeill stated that proper precautions should be taken when taking the boiler off the line, and also in putting boilers into service. By the Engineers' and Firemen's License Laws in Massachusetts all persons in charge of and operating steam boilers are required to be thoroughly proficient in this branch of their work; also, the person in charge of every steam boiler carrying a pressure exceeding twenty-five pounds per square inch is required to keep daily records of the trying of the safety valves, water columns, blow-offs and other appendages, also a record of the repairs and inspections made on the boiler. The subjective effect of this keeping of a record on both employer and employee cannot be over-estimated.

In connection with Question No. 3 above set forth, Mr. McNeill said that the prevention of steam boiler explosions is a general proposition in which the owner of the boiler, the manufacturer of the boiler and the engineer in charge, must all contribute their quota of care in their various lines, which can only be done by united effort as expressed and carried out by proper legal enactment. The speaker believed that the Commonwealth of Massachusetts is unquestionably in the lead in the matter of regulations governing the construction, installation and inspection of steam boilers and the licensing of engineers and firemen. This was quite generally conceded by the members of the convention to be the fact, and as proven by the fact that other States are copying the Massachusetts law. Such very important points as the temperature of the feed water and the location at which it shall be discharged and other matters which pertain to the safe operation of steam high-pressure boilers are all carefully looked after in this law. It is always necessary to have a full knowledge of all details connected with the case before advancing an opinion that shall be of any value as to the cause of an explosion.



J. F. WANGLER, TREASURER.

Mr. Charles S. Blake, secretary of the Hartford Steam Boiler Inspection Insurance Company, stated upon being invited to take the floor that he thought responsibility for explosions should be shared between boiler manufacturers, engineers and owners; he remarked incidentally that the manufacturers of tubes do not seem to be keeping up with the progress made by the manufacturers of other material entering into boiler construction. Higher pressures are being carried to-day than ever before, and the tubes have not kept pace with the march of improvement. Twenty-five years ago the average pressures ran from 80 to 100 pounds, and the tubes in use at that time were identical in thickness, except in specific instances, with those in use to-day, for pressures of from 150 to 175 pounds, and the average quality has not improved, so that the standard commercial tube of to-day is no better, if as good, as the tube of those days. Tubes should be stamped so that their source of origin could be located and the responsibility laid where it belongs when a casualty occurs through tube ruptures due to defect in manufacture. Tube failures are wofully common. Theoretically a tube will stand a greater internal pressure than external, but as a matter of practice a tube which is subjected to internal pressure more commonly fails than the tube subjected to external pressure; and if the tube is defective in weld with the external pressure the tendency is to close the opening; with the internal pressure the tendency is to open it. The speaker said that had he known that he would be asked to speak upon these topics, or had he been aware that they were to be discussed by notice in advance, such as is often given by engineering societies, he would have come prepared with ample data to sustain his propositions. Without having so prepared himself he did not like to generalize on the questions presented. He believed that more boilers explode under the age of fifteen years' use than over that period. His company distributes literature as to care in operation and maintenance of boilers, but it is unfortunate that except in a few isolated instances they are not backed up by city and State or Federal regulations. He thought the great trouble with tubes was not so much in the material as in the imperfect welding of the tubes.

Col. Meier told of a case in his experience where rupture of tubes had grown to be a chronic source of complaint at one plant, and he sent a man in quietly to see what he could learn as to the cause, and the man found that the engineer, desiring to cool down quickly, had been in the habit of throwing open the fire-doors and suddenly cooling the tubes, hence the trouble. The tubes ruptured right square off outside of the sheet. In another case the tubes had become choked with carbon deposits, due to the use of an objectionable compound composed of a poor grade of oil and sorghum molasses; when the use of this was discontinued the trouble abated at once. The boiler manufacturers must ask the insurance men to protect them by helping to stop such bad practices.

Mr. Durbin said they had been paying especial attention to the matter of securing proper curvature to the plate. They arrange to have a gage put on the plate as soon as it is turned out from the rolls and the matter watched in this way. The butt straps are brought to absolute circle with a former by a large hydraulic press, and in that way they are overcoming this difficulty complained of. They employ the Hartford Company to inspect every boiler they manufacture for the joint protection of themselves and their trade. Believing that life is no dearer or more valuable to the man on land than the man on the water the speaker hoped to see the day when an adequate Federal law would be in operation that would uniformly apply to all land boilers, thus doing away with the confusion resulting from conflicting enactments in the various States. At present it is almost impossible to keep constantly posted as to all the various conflicting provisions of laws adopted by the various cities and States. A boiler that will pass in Massachusetts will be rejected perhaps in Philadelphia and *vice versa*. He had come to this convention in the hope that something could be done to unify the various State laws. The matter of States rights seems to be the great difficulty in the way of a Federal law. He had interviewed the President about it and all who had talked with him agreed that Government supervision was necessary, as well for land as for marine boilers, but the question of States' rights seemed to be the great bugbear; Congress appeared not to be vested with power, except upon the waters and in the District of Columbia.

Mr. John J. Main, of Toronto, instanced cases of explosions, of which he presented photographs, some of which were due to faulty material, where the steel by analysis showed too high sulphur; some were due to faulty material and workmanship both, the boiler not being a true round and permitting constant breathing and a moving away from and returning to the circular form because of a long sheet underneath and two sheets overhead; the larger number of cases he had been called upon by the Government to investigate and report upon being caused absolutely by faulty operation, mostly in the case of locomotive boilers, due to low water. The speaker thought that there are too many poor boilers made, and this demonstrates the necessity for a uniform specification to have the backing of law throughout the Dominion of Canada.

Capt. H. P. Norton, U. S. N., representing the Bureau of Steam Engineering, the department that builds all the machinery for the United States Navy, boilers, engines, electric gear, etc., said that in the navy they never empty a boiler when hot, but allow the boiler to cool off naturally, and do not disturb anything until the boilers are perfectly cold; they close the boiler up and stop all circulation of air and let it cool off. He thought the best material is poor enough, and everything that is used by the Navy Department must strictly conform to specifications from which no deviation will be allowed; everything must be up to standard, and the department believe that in that way they secure better results. Very few of their boiler explosions when they have occurred have been due to faulty material because of rigid compliance with their own specifications; the greater proportion of accidents is due to carelessness or ignorance by attendants who have overlooked some of the regulations. Fresh or distilled water is used in all boilers. They require a safety valve to lift a certain distance, to open at a certain pressure and close at a certain pressure. An elaborate testing apparatus has been installed to determine the amount of lift, and this must be up to the requirements or it will be rejected.

Mr. Jas. T. Foord, Chief Inspector, Hartford Steam Boiler Inspection Insurance Company, was called upon and responded very briefly, stating that he concurred with the statements made by Mr. Blake. This was his first appearance before the Boiler Manufacturers' Association, and the result was so instructive that he had made a vow to come again, and hoped next time to come better prepared to discuss the subjects brought up. General Uhler referred to the matter of hydrostatic pressure test as having proved deleterious in many instances, and while he had stood rigidly for the rules and regulations he had come latterly more and more to the conviction that hydrostatic test was no good when applied to the lighter grades of material, especially of from 3/8 inch up to 3/4 inch, in which cases 150 percent of hydrostatic pressure pretty nearly meets the elastic limit of the material. The application of such a test means strain and he was about ready to abandon it.

Captain Norton stated that that they in the navy never apply the hydrostatic pressure cool, but always bring it up to warm pressure.

In response to some remark of Genl. Uhler about the inadequacy of taking the coupon from the edge of the plate as a test of value, Mr. John J. Main, of Toronto, remarked that he thought it was all right to take the coupon from the edge because the edge was where the strain would ordinarily be felt, where the pressure will take place; that is the weak place, because there you drill the hole.

TUESDAY AFTERNOON SESSION.

The first part of Tuesday afternoon was occupied by an executive session, at which certain reports of committees, etc., were read and discussed; after which the following Topical Question was presented for discussion: "There seems to be a very wide range in engineers' ideas of what amount of metal is necessary to be taken out after a hole is punched in a plate. To remove all doubt as to the possibility of a fracture from that operation an answer to the following is suggested: Is a hole enlarged ⅛ or 1/16 all around sufficient? Is a hole enlarged ¼ or ⅛ all around sufficient? Is a hole enlarged ⅜ or 3/16 all around sufficient? I would like to get the practical experience of the A. B. M. A. as to which procedure removes the possibility."

Mr. Main remarked that some eighteen or twenty years ago he knew of tests made in England as to the difference between punching and reaming a hole or drilling it, which established that a ¾-inch hole would require to be punched ½ inch in diameter in order to make it equal to a drilled hole, and a punched hole ¾ inch in diameter would not stand within 20 percent as much as a drilled hole; but a reamed hole, by taking out ⅛ inch all around, would eliminate all the damaged part of the plate and would then stand just as good a physical test as the drilled hole would; but any practical man will admit that it depends largely upon the condition of the punch and the die. These must be absolutely sharp and clean cutting.

President Meier appointed as Committee on Uniform Specifications for the ensuing year the following: M. A. Ryan, chairman; H. D. Mackinnon, M. A. Broderick, Geo. N. Riley, A. J. Schaaf, R. E. Ashley, Dennis Wholey and T. M. Rees. Mr. Ryan, declining appointment, moved that Col. E. D. Meier be named as chairman of the committee and paid a high compliment to Col. Meier's efficient labors in the past upon the committee. The motion was seconded by Capt. T. M. Rees and carried unanimously, Capt. Lappan remarking that the president was *ex-officio* a member of all committees.

Secretary Farasey read an interesting letter, written by Capt. T. M. Rees while abroad, referring to the matter of the relative merits of the lever and the spring pop safety valve in marine practice, in regard to which it appeared that an interesting hearing had been held before the Board of Inspectors of Steam Vessels. Capt. Rees thought that this would be an interesting topic for discussion at next year's meeting in Boston.

The convention adjourned to 4:30 P. M. Wednesday, the morning of Wednesday being devoted to the trip to the Illinois Steel Company's plant at Gary.

Trip to Gary.

An early start was made Wednesday morning in a special Pullman train for Gary, where the party was received and shown every courtesy by Messrs. F. T. Bentley, traffic manager Illinois Steel Company, P. W. O'Brien, sales department, and J. B. Arnold, sales department; while Mr. B. L. Cogshall, of the general superintendent's office, acted as general guide, answering all inquiries, etc. The party visited the docks, where they witnessed unloading of ore from ore boats and the way in which great economies are obtained by the use of a grab-all that is capable of unloading 1,500 tons of ore an hour, ten tons being taken up at a grab and 95 percent of the unloading being done without any shoveling, and with the employment of one or two men only. Thence the party proceeded to the blast furnaces, through the power stations, where over 100,000 horsepower is being developed daily, and more when needed, by some 42 gas engines of 3,500 horsepower each, all using gas from the furnaces that would otherwise go to wsate. By exploding the gas in these engines three times the amount of power is obtained that could be had if burned under boilers and power made by steam in the old way. These gas engines are all of the Allis-Chalmers make, while the blowing engines of a rated capacity of 2,500 horsepower each are of the Westinghouse make. The party went up on the open hearth floor and saw the process of making basic open hearth steel from the fluid pig iron, brought in cars from the blast furnaces and poured in molten shape into the open hearth furnaces. Thence to the rail and merchant mills. They were told that there is in stock there at present nearly two million tons of ore. The entire plant is electrically operated by power from the gas engines, some steam equipment being carried as a reserve. The guide told us that it takes 110 cars of coke and 100 cars of coal to run the place a day when it is running full. There are now some 9,200 men employed, which includes some who are engaged in constructing work, but the mill is not operating at full capacity at present. An interesting operation was the raising of metal by magnets capable of raising 12,000 pounds at one lift. The plant occupies some two square miles of territory, over 25 percent of which is made ground. The above particulars are not vouched for as technically correct, but were part of the story that was told the party as they went through the immense establishment that filled the minds of all with awe at its magnitude and importance, a most amazing feature being the great extent to which machinery had minimized human hands and still there was work for so many human hands to do. The plant is said to have cost over fifty million dollars, and looks as if it might in time wipe Pittsburg off the map. On the return trip the party had luncheon in the Pullmans and returned to the city about the middle of the afternoon well pleased with the experience and grateful to those who had made it possible for them to see so much in so short a time.

WEDNESDAY AFTERNOON SESSION.

At the session held late Wednesday afternoon the following resolutions were unanimously adopted and later read at the banquet Thursday night by Secretary Farasey, viz.:

Resolutions of Thanks for Courtesies.

At the close of a most successful convention, it is our pleasant duty to acknowledge the many courtesies received at the hands of our Chicago hosts and others.

We, therefore, hereby tender our thanks to the members of the Supplymen's Association, A. B. M. A., whose indefatigable labors and cheerful welcome to each and every one of us made us feel at home and caused every moment of our stay here to be replete with enjoyment, so adequate were their arrangements and so completely did they anticipate our every want and provide for every contingency.

It seems invidious to specialize upon individuals where all were deserving of commendation; but we desire to especially mention Mr. W. O. Duntley, chairman of the general entertainment committee, and president of the Supplymen's Association, the chairmen and members of the various sub-committees under his direction, Messrs. George A. Rees, John T. Corbett, Thos. Plunkett, L. R. Phillips, C. M. Chamberlain, C. L. Bitting and W. H. S. Bateman.

We also tender our thanks to Messrs. P. W. O'Brien, P. T. Bentley and J. B. Arnold for the perfect arrangements of the excursion to the Illinois Steel Company plant at Gary, which was most instructive and enjoyable, and to Mr. B. L. Cogshall for the courtesy and promptness with which he answered all our various inquiries in regard to the details of that magnificent plant.

We tender our thanks also to Admiral H. I. Cone, engineer-in-chief Bureau of Steam Engineering, U. S. Navy Department, and to his able and urbane representative, Capt. H. P. Norton, U. S. N., who was of valuable assistance in our deliberations; to the Hon. Charles Nagel, Secretary of Commerce and Labor, for his courtesy in sending, as a representative of the Steamboat Inspection Service, Gen. George Uhler, Supervising Inspector General, to whose conscientious and fair-minded decisions many of our members bear grateful testimony and whose active part in our debates was as usual of great advantage to us; to Hon. Eben S. Draper, Governor of Massachusetts, for commissioning as his special representative Mr. Joseph H. McNeill, Chairman of the Board of Boiler Rules of the Commonwealth of Massachusetts, whose participation in our proceedings was of great benefit to us; to the Hartford Steam Boiler Inspection Insurance Company, for the presence and co-operation of the able representatives of that Company, Messrs. Chas. E. Blake, secretary, and James T. Foord, chief inspector; also to Mr. Arthur E. Brown, the past president and special representative of the International Association of Master Boiler Makers, who brought to us the greetings of his association, which works along lines similar to our own in the direction of improving the design and construction of boilers; also to the courteous representatives of the technical trade press, for reports of our meetings.

We further tender to his Honor Mayor Busse, of Chicago, our thanks for the cordial welcome extended to us through Hon. George M. Bagby, assistant corporation counsel, which was delivered with so much eloquence.

Special mention should be made and our thanks tendered to Joseph T. Ryerson & Son for their hospitality of this afternoon.

Finally, on behalf of the ladies of our party, we tender thanks to all the gentlemen to whom they are indebted for the beautiful automobile rides about the city of Chicago.

The Banquet.

The banquet at the Auditorium Hotel, Thursday night, was an elaborate affair, at which Capt. Jas. Lappan of Pittsburg officiated as toastmaster.

The speakers were Hon. Howard Hayes, assistant corporation counsel, Chicago, Ill.; M. A. Ryan, Duluth, Minn., fifth vice-president A. B. M. A.; Capt. Harold P. Norton, U. S. N., Bureau of Steam Engineering, Navy Dept., Washington, D. C.; John J. Main, Toronto, Canada; General Uhler, Supervising Inspector-General, Washington, D. C.; Arthur E. Brown, past president International Association of Master Boilermakers, Louisville, Ky.; George N. Riley, National Tube Company, Pittsburg, Pa.; W. H. S. Bateman, secretary Supplymen's Association, A. B. M. A., Philadelphia, Pa.; Joseph H. McNeill, chairman Board of Boiler Rules, Boston, Mass.; James D. Farasey, secretary A. B. M. A., Cleveland, O., and Miss A. B. Chute, the only lady boiler manufacturer, Youngstown, O.

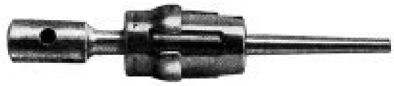
At the banquet the Chicago Pneumatic Tool Company, as usual on these occasions, distributed handsome souvenirs, the one this time being a pin bearing the American flag on a shield, with the old Fort Dearborn in center, as a remembrance of the visit to Chicago.

Supply Men's Association.

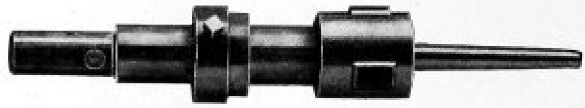
The Supplymen's Association elected officers on Thursday for the ensuing year as follows: W. O. Duntley, president, Chicago, Ill.; J. T. Corbett, vice-president, Chicago, Ill.; W. H. S. Bateman, secretary, Philadelphia, Pa.; H. B. Hare, treasurer, Cleveland, O. Executive Committee: D. J. Champion, Cleveland, O., chairman; Thomas Aldcorn, New York, N. Y.; F. B. Slocum, Brooklyn, N. Y.; C. M. Chamberlain, Chicago, Ill.; R. S. Groves, Philadelphia, Pa.

The following were registered as members or guests:

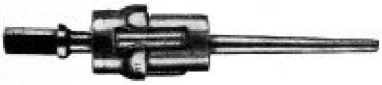
Wm. Allison, Punx'y Boiler Works, Punx'y, Pa.; R. E. Ashley, Muskegon Boiler Works, Muskegon, Mich.; C. J. Albert, Cleveland Pneumatic Tool Company, Chicago, Ill.; G. B. Arnold, Illinois Steel Company, Chicago, Ill.; Mrs. C. J. Blaker (with Scheibley), Cincinnati, Ohio; W. H. S. Bateman, Parkesburg Iron Company, Champion Rivet Company, Philadelphia, Pa.; Mrs. W. H. S. Bateman, Philadelphia, Pa.; G. L. Bitting, Worth Bros. Company, Chicago, Ill.; D. A. Brown, official reporter, Cincinnati, Ohio; T. F. Brosnahan, A. M. Castle & Company, Chicago, Ill.; G. E. Burnach, Lunkenheimer Company, Cincinnati, Ohio; F. T. Bentley, Illinois Steel Company, Chicago, Ill.; J. T. Corbett, J. T. Ryerson & Son, Chicago, Ill.; Mrs. J. T. Corbett, Chicago, Ill.; D. J. Champion, Champion Rivet Company, Cleveland, Ohio; Mrs. D. J. Champion, Cleveland, Ohio; C. M. Chamberlain, secretary A. M. Castle & Company, Chicago, Ill.; Mrs. C. M. Chamberlain, Chicago, Ill.; C. A. Carscadin, V. P. Kirby Equipment Company, Chicago, Ill.; Mrs. C. A. Carscadin, Chicago, Ill.; W. H. Connell, Jr., Hilles & Jones Company, Wilmington, Del.; H. S. Covey, Cleveland Pneumatic Tool Company, Cleveland, Ohio; G. A. Cameron, Scully Steel & Iron Company, Chicago, Ill.; P. J. Conrath, National Tube Company, Pittsburg, Pa.; Mrs. P. J. Conrath, Pittsburg, Pa.; J. B. Corby, Corby Supply Company, St. Louis, Mo.; Mrs. J. B Corby, St Louis, Mo.; J. S. Chichester, W. G. Hagar Iron Company, St Louis, Mo.; C. F. Bowes, manager Lunkenheimer Company, Cincinnati, Ohio; J. B. Dick, Phœnix Iron Works, Meadville, Pa.; W. H. Dangel, Scully Steel & Iron Company, Chicago, Ill.; W. O. Duntley, president Chicago Pneumatic Tool Company, Chicago, Ill.; Mrs. W. O. Duntley, Chicago, Ill.; J. F. Duntley, Detroit, Mich.; W. A. Dowler, Revere Rubber Company, Chicago, Ill.; Mrs. W. A. Dowler, Chicago, Ill.; T. E. Durbin, general manager Erie City Iron Works, Erie, Pa.; T. L. Dodd, Worth Bros. Company, Chicago, Ill.; Mrs. T. L. Dodd, Chicago, Ill.; E. B. Day, Industrial World, Pittsburg, Pa.; J. D. Farasey, secretary A. B. M. A., Cleveland, Ohio; Mrs. J. D. Farasey, Cleveland, Ohio; Miss Marie Farasey, Cleveland, Ohio; F. G. Fernstrum, Menominee Boiler Works, Menominee, Mich.; H. C. Finlay, Otis Steel Company, Chicago, Ill.; Wm. A. Gates, National Boiler Works, Chicago, Ill.; Mrs. W. A. Gates, Chicago, Ill.; Columbus Dill, Ashton Valve Company, Boston, Mass.; Mrs. Columbus Dill, Boston, Mass.; Harry Darby, Missouri Boiler Works, Kansas City, Mo.; Mrs. H. Darby, Kansas City, Mo.; E. R. Gustavus, Reliance Boiler Works, Oshkosh, Wis.; H. B. Hare, Otis Steel Company, Ltd., Cleveland, Ohio; E. T. Hendee, Jos. T. Ryerson & Son, Chicago, Ill.; Mrs. E. T. Hendee, Chicago, Ill.; L. M. Henoch, treasurer Scully Steel & Iron Company, Chicago, Ill.; Mrs. L. M. Henoch, Chicago, Ill.; Chas. Heggie, secretary Scully Steel & Iron Company, Chicago, Ill.; John P. Hoelzel, Fort Pitt Forge Company, Pittsburg, Pa.; Wm. Kehoe, Kehoe's Iron Works, Savannah, Ga.; Mrs. Wm. Kehoe, Savannah, Ga.; Miss Kehoe, Savannah, Ga.; Miss Helen Kehoe, Savannah, Ga.; A. W. Klingman, Bourne Fuller Company, Cleveland, Ohio; Geo. R. Lombard, Lombard Iron Works, Augusta, Ga.; Mrs. G. R. Lombard, Augusta, Ga.; Andrew Jack, Manistee, Mich.; T. H. Johnson, purchasing agent Casey, Hedges Company, Chattanooga, Tenn.; J. A. Kinkead, Parkesburg Iron Company, New York, N. Y.; A. M. Mueller, Jos. T. Ryerson & Son, Chicago, Ill.; Miss Alice M. Mueller, Chicago, Ill.; L. P. Mercer, Parkesburg Iron Company, Chicago, Ill.; Mrs. L. P. Mercer, Chicago, Ill.; Joseph H. McNeill, chairman board of boiler rules, Boston, Mass.; E. McDuffie, Marion Iron Works, Marion, S. C.; G. R. Maupin, J. Faessler Manufacturing Company, Moberly, Mo.; George Mason, Jr., Scully Steel & Iron Company, Chicago, Ill.; E. F. McCabe, McCabe Boiler Works, Newark, N. J.; H. B. McLelland, Jenkins Bros., Chicago, Ill.; John Nooter, John Nooter Boiler Works, St. Louis, Mo.; Harold P. Norton, captain United States navy, Stoneleigh Court; P. W. O'Brien, Illinois Steel Company, Chicago, Ill.; Thos. Plunkett, Revere Rubber Company, Chicago, Ill.; Mrs. Thos. Plunkett, Chicago, Ill.; L. R. Phillips, Na-



"Boss" Roller Expander (Hand Use)



Arch Flue Expander

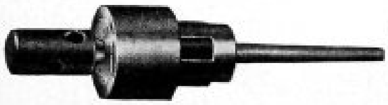


Boss' Roller Expander (Self-Feeder)

FAESSLER

BOILER MAKERS' TOOLS

ARE STEEL THROUGHOUT



Universal Expander (Hand Use)

Universal Expander (Self-Feeder)

This strong point is but one of many that skilled boiler makers invariably recognize in Faessler Tools.

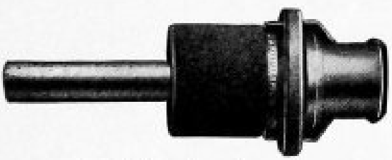
Space here does not permit describing each in detail. If it did, we think we could easily convince you beforehand of the ability of any Faessler tool to withstand the hardest knocks of severe service and do first-class work under trying conditions.

But better than this, we want you to see for yourself in your own shop that our claims are not exaggerated. Tell us the size and kind of tools needed, and we will supply your wants on condition that our tools must prove highly satisfactory in every way or may be returned at the end of a 30-days' trial.

TRADE MARK BOSS REGISTERED

Removable Collar Expander (Hand Use)

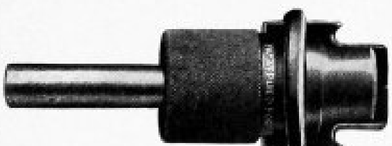
Removable Collar Expander (Self-Feeder)



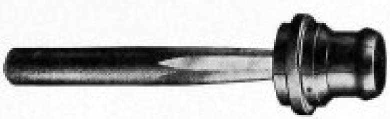
Rapid Beading Expander.

J. FAESSLER MFG. CO.

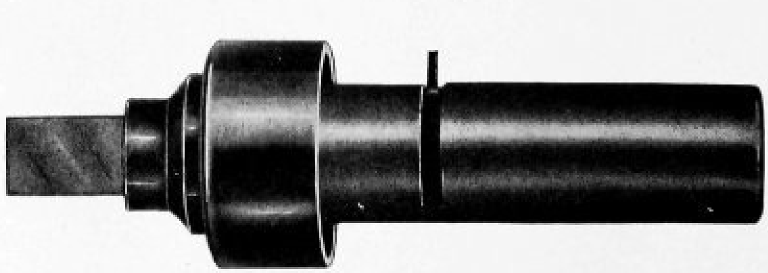
MOBERLY, MO.



Rapid Beader Tool



Improved Sectional Expander



"Perfect" Flue Cutter

tional Tube Company, Chicago, Ill.; Mrs. L. R. Phillips, Chicago, Ill.; J. L. Presk, A. M. Castle Company, Chicago, Ill.; G. A. Rees, vice-president Chicago Pneumatic Tool Company, Chicago, Ill.; Mrs. George A. Rees, Chicago, Ill.; F. B. Rausch, Jos. T. Ryerson & Son, Chicago, Ill.; C. B. Rowland, vice-president Continental Iron Works, Brooklyn, N. Y.; Miss Mabel Stadler, Chicago, Ill.; F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.; G. A. Schust, S. F. Bowser & Company, Ft. Wayne, Ind.; J. Don Smith, Valk & Murdock, Charleston, S. C.; W. C. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio; A. J. Schaff, chief engineer Monongahela Consolidated River Coal & Coke Company, Pittsburg, Pa.; Mrs. A. J. Schaff, Pittsburg, Pa.; W. B. Simpson, president A. M. Castle & Company, Chicago, Ill.; Mrs. W. B. Simpson, Chicago, Ill.; T. J. Schreiber, A. M. Castle & Company, Chicago, Ill.; George Slate, THE BOILER MAKER, New York, N. Y.; Robert T. Scott, Ind. Pneumatic Tool Company, Chicago, Ill.; Mrs. Robert T. Scott, Chicago, Ill.; Dan Shea, Shea Boiler Works, Memphis, Tenn.; R. S. Sanford, A. M. Castle & Company, Chicago, Ill.; J. B. Scheibley, McIlvain & Spiegel, Cincinnati, Ohio; Mrs. J. B. Scheibley, Cincinnati, Ohio; A. Schoonmaker, Graham Nut Company, Pittsburg, Pa.; R. M. Tuller, A. M. Castle & Company, Chicago, Ill.; George Thomas (3d), treasurer Parkesburg Iron Company, Parkesburg, Pa.; George A. Tibbals, Continental Iron Works, Brooklyn, N. Y.; Gen. George Uhler, superintending inspector general, Washington, D. C.; T. P. Wallace, W. G. Hagar Iron Company, St. Louis, Mo.; Irving Washington, Jos. T. Ryerson & Son, Chicago, Ill.; D. Wholey, Wholey Boiler Works, Providence, R. I.; G. A. Woodman, Kirby Equipment Company, Chicago, Ill.; Robert Bruce, La Belle Iron Works, Steubenville, Ohio; A. L. Beardsley, Cleveland Twist Drill Company, Chicago, Ill.; Robert J. Bower, London Guarantee and Accident Company, New York; Chas. S. Blake, Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.; M. H. Broderick, Broderick-Quinlin Manufacturing Company, Muncie, Ind.; Mrs. M. H. Broderick, Muncie, Ind.; Fred C. Boegersausen, Parker Boiler Company, Chicago, Ill.; Henry Brobst, Central Boiler Works, Grand Rapids, Mich.; Mrs. Henry Brobst, Grand Rapids, Mich.; Arthur E. Brown, L. & N. R. R. Co., Louisville, Ky.; A. C. Castle, A. M. Castle & Company, Chicago, Ill.; L. E. Cullem, Star Boiler Works, Clinton, Iowa; A. H. Chapman, Walsh & Weidner Boiler Company, Chattanooga, Tenn.; P. E. Carhart, Illinois Steel Company, Chicago, Ill.; J. T. Coleman, Hartford Steam Boiler & Inspection Company, Chicago, Ill.; D. R. Carmode, National Boiler Works, Chicago, Ill.; D. B. Clark, Hooven-Owens-Rentschler Company, Chicago, Ill.; Miss A. B. Chute, Youngstown, Ohio; L. J. Davis, Ingersoll-Rand Company, New York; E. C. Downey, National Tube Company, St. Louis, Mo.; W. J. Edwards, The Brownell Company, Dayton, Ohio; Jas. L. Foord, Hartford Steam Boiler Inspection & Insurance Company, Chicago, Ill.; H. A. Flagg, Ohio Seamless Tube Company, Chicago, Ill.; J. F. Gannow, Colonial Steel Company, Chicago, Ill.; C. W. Hayes, Chicago Pneumatic Tool Company, Chicago, Ill.; Mrs. C. W. Hayes, Chicago, Ill.; C. K. Heasley, Fidelity and Casualty Company, New York; Geo. H. Houston, Houston, Stanwood & Gamble Company, Cincinnati, Ohio; Geo. Hibben & Company, South Chicago, Ill.; S. E. Hackett, Jos. T. Ryerson & Son, Chicago, Ill.; C. L. Humpton, The Parkesburg Iron Company, Parkesburg, Pa.; A. W. Johnson, London Guarantee & Accident Company, Chicago, Ill.; J. J. Keefe, Independent Pneumatic Tool Company, Chicago, Ill.; Mrs. J. J. Keefe, Chicago, Ill.; W. E. Keely, "Electrical World," Chicago, Ill.; M. Llewelyn, president Walsh & Weidner Boiler Works, Chattanooga, Tenn.; Jno. P. Moses, Jos. T. Ryerson & Son, Chicago, Ill.; Robert T. Mussett, Waterloo Steam Bailer Works, Waterloo, Iowa; E. J. Murray, LaBelle Iron Works, Chicago.

(Continued on page 337.)

THE BORSIG LOCOMOTIVE SHOPS.

The first locomotive built in Germany was constructed in the year 1841 by A. Borsig for the Berlin-Anhalt Railway. By 1870, thirty years after, nearly 3,000 locomotives had been built, although the shops were, according to present ideas, equipped in a very primitive way.

The works, which up to the end of the nineteenth century were situated in the heart of Berlin, became inadequate, and from urgent necessity the new shops of the firm were established in Tegel, a suburb of Berlin, along the most modern lines.

Locomotive construction, which has always been the principal work of the Borsig firm, remains its chief line of manufacture in the new plant. Since their beginning the new shops have turned out more than 3,000 locomotives, and with the present yearly production of 500 to 600 engines, the total output of the firm since the start has rapidly grown to 8,000. It is, therefore, of interest to take a brief survey of the shops, examining some of their methods of work, machinery and appliances. Only a few operations have been selected, which

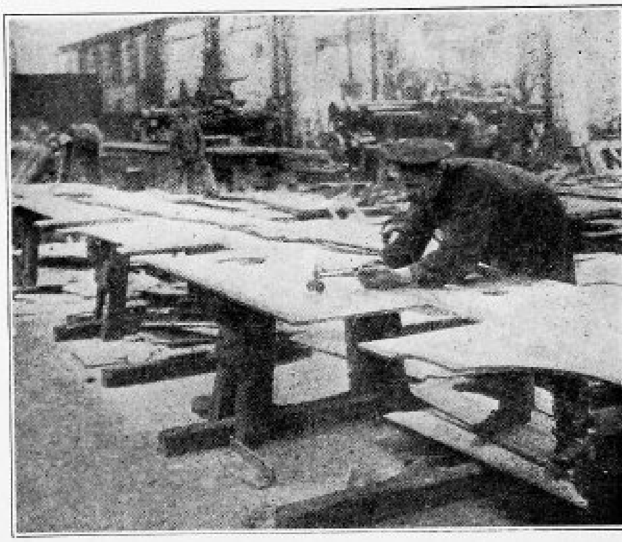


FIG. 1.—CUTTING OUT FRAME PLATES WITH TORCH.

will show the systematic methods of work and the tendency to substitute machine for hand work, to secure interchangeable parts.

An important part of the locomotive is the frame. According to the most common European practice it consists primarily of two rectangular side plates, rolled out of the ingot of steel to the size required. In machining this sheet a plate templet of the finished piece is first made from the construction drawings and not a special frame-templet drawing. This thin plate templet is used in the layout for cutting out the frame plates, as well as to mark the screw and rivet holes; then the several frame plates are cut out with autogenous cutting appliances. Plates up to 250 millimeters (9.85 inches) thick can be cut out with such a machine.

This process is clearly shown in Fig. 1. The burner construction is that of the chemical factory Griesheim Elektron, in Frankfort-on-Main. The autogenous cutting out of plates 20 millimeters (0.7874 inch) thick, for example, requires, say, about ten minutes, consuming 110 liters (3.88 cubic feet) of hydrogen and 300 liters (10.59 cubic feet) of oxygen.

It will be noted that the cutting nozzle of the torch is supported by a pair of small wheels, which enable the operator to roll it along easily and steadily. In cutting out openings it is necessary to punch or drill a small hole as a starting point.

In cutting out, the plate is bent, and it has to be straightened, which is done upon the plate-straightening machine shown in Fig. 2. This machine has altogether seven rolls for straightening out the plates. It will take a plate up to 1,800 millimeters (70.86 inches) wide and 5 to 35 millimeters (0.196 to 1.378 inches) thick. It is electrically driven.

After cutting out and straightening the individual sheet it is packed and clamped together with several others for milling on the outside and cut-out edges. This is by a triple-frame milling and slotting machine with three cutting heads, each driven by an individual motor. This machine will take plates up to 10,500 millimeters (34½ feet) long and 1,900 millimeters (74.8 inches) broad in packs up to 220 millimeters (8.7 inches) high, using three cutters at the same time.

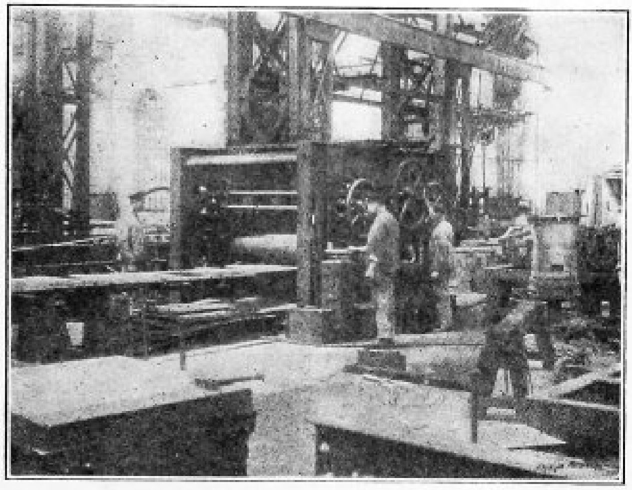


FIG. 2.—STRAIGHTENING THE FRAME PLATES.

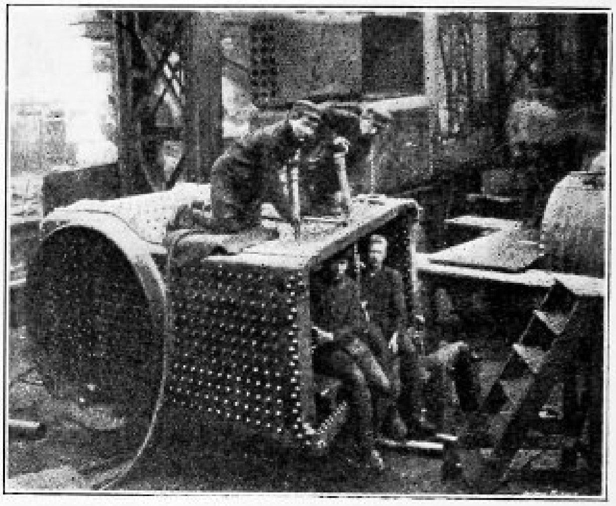


FIG. 4.—RIVETING THE FIRE-BOX.

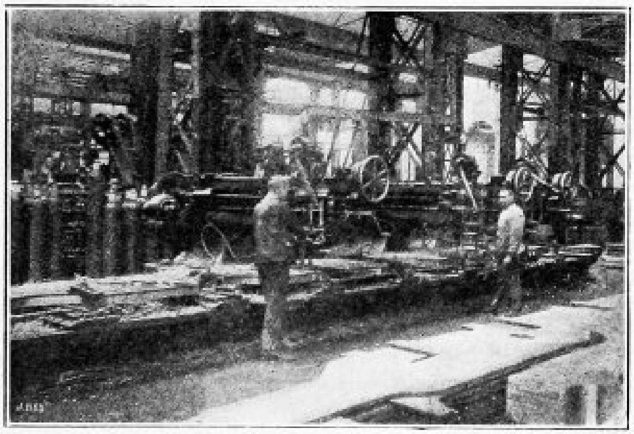


FIG. 3.—DRILLING THE FRAME PLATES.

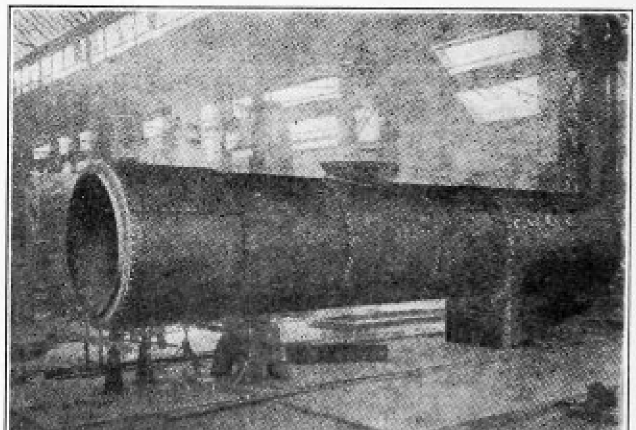


FIG. 5.—TESTING ALINEMENT OF BOILER.

Fig. 3 shows the arched-roof construction, which is not common in the United States, and the crane runway, practically an independent structure from the building itself.

High-speed steel milling cutters of 100 millimeters (3.94 inches) diameter are in use For a pack 220 millimeters (8.7 inches) high, the feed is 15 to 18 millimeters (0.59 to 0.70 inch) per minute with 15 millimeters (0.59 inch) cut.

From the milling machine the pack is taken to the drilling machine, where the requisite screw and rivet holes are drilled as already laid out with the plate templet.

In Fig. 3 is a triple drilling machine, which is also equipped with three heads and a motor for each. The housings will take a width of 1,700 millimeters (66.9 inches), and the bed length of the entire machine is 9,000 millimeters (29½ feet). This machine drills holes to 380 millimeters (14.9 inches) deep and 100 millimeters (3.94 inches) diameter, with a drill speed of 115 revolutions per minute.

With these operations the machining of the frame-plate edges is completed, and the plates necessary for assembling the complete frame with the necessary cross braces, brackets, etc., have been prepared.

The laying out, cutting out, straightening, milling and drilling of the frame plates for a C-1 tender locomotive of about 50 tons weight empty and about 65 tons working weight; that is, the entire work upon the frame side plates of such an engine up to the delivery of the plate for the assembling requires a time of about seven days. Such a plate is 9,200 millimeters (30 feet) long, 1,200 millimeters (47¼ inches) high and 15 millimeters (0.59 inch) thick. When taking in hand at the same time about 25 or 30 similar frames, there is required for machining a complete frame in the above described mutiple manner, including also the erection and assemblage with all other parts, such as cross connections and brackets, up to the putting of the boiler on the frame and mounting the cylinder, a period of about three weeks.

Fig. 4 shows a nearly completed fire-box. The stay-bolts connecting the inner and outer sheets are threaded their whole length or only at the ends, as the case may be. The sheets are tapped by pneumatic drilling machines. The ends of the bolts are afterward riveted with a pneumatic hammer. With such a pneumatic tool about forty stay-bolts per hour can be riveted, according to the softness of the material.

The completed fire-box is then joined to the longitudinal shell, and then the whole boiler, with all its principal parts, is loosely fastened together as in Fig. 5. This shows the final riveting; the boiler is accurately alined and tested, in order to obviate any work after the final riveting. The boiler is mounted on the frame, and installation of the other locomotive parts begins.—*American Machinist.*

ELECTRO-CHEMICAL ACTION AND BOILER CORROSION.

It is somewhat disappointing that, with all our present scientific knowledge, there are certain phenomena in connection with the corrosion of steam boilers which, though they are perfectly well known and very troublesome, are due to causes which are not clearly understood. Many explanations have been given, and yet little really seems to be known about them. There can be no doubt, however, that they are due either to chemical or electrical action, probably to both. To what extent each of these is responsible for diseases, such as pitting, wasting, grooving, etc., to which boilers are liable, has for long been a matter provocative of arguments and discussions. Volumes have been written on the subject, and numberless cures, some of them, to say the least, ridiculous, have been advocated and tried. The diseases, however, still continue, and in spite of all antidotes remain a constant source of worry to the owner and to the engineer in charge. The high temperatures and pressures now in use have also increased their importance. It is perhaps more than can be reasonably expected that any certain cure should be found for these evils; and all that we can hope for is that they may be mitigated. Enough is, of course, known to enable us to do this, but it still remains that boilers deteriorate from causes which in some cases are most obscure.

It is, we believe, held by some authorities of high standing that all kinds of corrosion of iron, in whatever form, may be put down to electrolysis, or, as it is more commonly known among engineers, galvanic action. We are not prepared to endorse this fully, although there is no doubt that many forms of corrosion arise largely, if not entirely, from minute electric currents which are set up between different parts of boilers when in contact with water. It does not appear, however, that our knowledge is yet sufficient to enable us to say definitely that purely chemical action is free from blame. It may prove to be so, but more evidence is needed before we can be sure on this point. There is nothing new in this theory of electrolytic action. For years it has been regarded as an enemy to boilers, and has been combated in many ways, and who among us, with any experience of the working of boilers, does not know how firm is the faith of some men that plates of zinc attached by various ingenious methods inside boilers are a sure charm against corrosion? The theory of the action of these plates may at times be very vague in the minds of the users, but the fact that the plates waste away is often held to be a guarantee that in so doing they save the boiler itself. This is, no doubt, frequently the case, but, unfortunately, like many other so-called cures, zinc is not always successful. It is still quite possible, however, that electrolytic action has much to do with the corrosion of boilers. That it has escaped conviction is perhaps due to the difficulty there has been in obtaining absolute proof, though it has been easy to speak in a mysterious way of electric action when certain phenomena have puzzled us.

Now, in order to have electrolytic action it is, of course, necessary to have an electro-chemical system. In steam boilers we frequently have it, for therein electrodes of differing potentials may easily exist; nay, probably always do exist. For instance, in a locomotive boiler the shell may sometimes be the anode and the tubes the cathode, the water being the electrolyte, while, under other conditions, the reverse may be the case, the tubes being the anode and the shell the cathode, and it may take very little—a slight polarization possibly—to change the one into the other. The composition of the water also is an important factor. Probably in most boilers using ordinary water the iron of the boiler is the anode, and therefore wastes away. By the introduction of zinc, which is electro-positive to iron, the latter may often be converted into the cathode element and be preserved at the expense of the zinc. The copper ferrule, sometimes introduced between an iron tube and the tube plate, at once introduces a voltaic couple, the iron tube in this case forming the anode and becoming the victim of electrolytic action, which takes place in the form of grooving near the ferrule, or in pitting along the tube. A particle of carbon or cinder in the iron, which is electro-negative to that metal, may also set up this action, again at the expense of the iron, the result being the small pit-holes so often found where corrosion is in progress. It does not, however, appear to be necessary to assume the existence of two elements within a boiler; couples may be set up by the iron itself, for they may easily exist, particularly in the commercial form of that metal, and in the conditions accompanying its use. Previous physical treatment, internal strains and inequality of temperature are probably quite sufficient to acaccount for electrolytic action.

Bearing upon this subject, a number of very interesting experiments have recently been carried out by Prof. C. F. Burgess, of the University of Wisconsin, with the object of ascertaining whether similar corrosive results to those found in actual boilers could be produced by means of minute electric currents in a laboratory apparatus. The experiments were made with a small model boiler, means being employed to measure accurately the magnitude of any small currents that might be set up. The apparatus used consisted of an iron pipe 17 inches long by 7 inches in diameter, which had its ends closed by screwed caps, in each of which there was a hole provided with a stuffing-box, the holes being placed somewhat below the centers of the caps. These stuffing-boxes were provided so that an inner iron fluetube, 1⅞ inches in diameter, which was passed through the caps, could be insulated from the shell, and at the same time allow the joint to withstand a pressure of about 100 pounds per square inch. Asbestos packing was found to be most suitable for this purpose. On the upper part of the shell a steam gage was fitted and a small cock for the release of the pressure; also a cock for the introduction of water. At the bottom of the shell was another cock for drawing off the water and sediment. A blast flame inside the fluetube was used as a means of applying heat. Between the inside and the outside tubes electrical connections were made through electrical measuring instruments, consisting of a mil-ammeter and a mil-voltmeter. A large number of tests were carried out with this apparatus, the boiler being charged with different kinds of water, while various conditions as to heating and cleanness were employed. Prior to each run, or series of runs, on a given water, the interior of the boiler was thoroughly cleaned, after which 6,000 cubic centimeters of water were introduced, allowing a steam space of about 2,000 cubic centimeters.

The tests showed curious results, particularly with regard to the variations of the electric current, these variations being in some cases somewhat unaccountable. In the first test referred to distilled water was used, and to this were added 3 grammes of amidol, the resulting solution being about 6,000 cubic centimeters in amount. In all the experiments in which distilled water was used the water was produced under conditions that cause aeration, and air in boiler-water is usually regarded as an important factor, though to what extent it is deleterious is not very accurately known. As soon as the water was introduced (at ordinary temperature) it was noticed that the current suddenly rose to 0.075 ampere, but the flow was only momentary, and continued only for a few minutes, decreasing rapidly at first and then more slowly, till at the end of 260 minutes it was only 0.0085 ampere. What the cause of this was does not appear to be very clear, but Prof. Burgess thinks that it may have been due partly to polarization effect, both at the anode and at the cathode. This may possibly have accounted for it. The differences in the composition or previous treatment of the iron forming the inner and the outer tube, respectively, might, as he suggests, have been sufficient to cause the initial electromotive force which caused the current, while gradual polarization may have caused the decrease of the current that was noted.

When heat was applied to the inner tube, after the lapse of 260 minutes, the current again rose to a maximum of 0.067 ampere, which point was reached somewhat before the maximum steam pressure of 100 pounds per square inch was attained. This latter occurred about 306 minutes after the commencement of the test. From this point there was at first a rapid decrease in the current, which drop, however, soon became slower, and at the expiration of 440 minutes, when the source of heat was removed, it had fallen to just below 0.015 ampere. At this point a rather curious thing was noticed. When the heat was removed the current suddenly made a slight jump up, but at once fell off rapidly till it reached almost zero. This sudden jump in the current when the heat was shut off was, in fact, noticed during many of the experiments, independent of the kind of water contained in the boiler; the jump, however, was not always a sudden rise and then a drop, but sometimes a sudden drop and then a rise. As before stated, different kinds of water were used; in some cases the boiler being filled with pure distilled water, while different substances, such as pyrogallic acid, hydrogen peroxide, soda ash and barium hydrate were introduced in small quantities, the soda ash in the proportion of about 1 pound per 1,000 gallons. In this case the effect of the soda was to increase the conductivity of the electrolyte, and to increase the current flow, which amounted at the maximum to about 0.044 ampere. This was considerably more than was noticed when distilled water was used. The voltage also was higher, reaching a maximum of about 0.100. With distilled water the maximum voltage was about 0.064.

A noticeable feature of the tests was that variations of pressure have little or no effect on electrolytic action, whereas temperature appears to influence the amount of current generated to a marked degree, and this was particularly observable in the case where soda ash was introduced into the water. If this chemical was employed in considerable quantities, it was found that the heated fluetube become the cathode element, and the boiler shell the anode, and we believe that in actual practice this has been found to be the case, the shell being attacked by corrosion, and the tubes remaining free from it.

In order to test the apparatus under conditions as nearly as possible akin to actual practice, trials were made in which, after the boiler had been tested, it was allowed to cool down and stand for sixteen hours short circuited, after which it was again tested while still containing the water supplied to it for the previous experiment. On being heated up again the current was found to be smaller than on the previous run; and on being cooled down again, and once more heated, the current was smaller still. In another case, after the apparatus had been allowed to remain short circuited for forty hours, heat was applied. During the first half of this test it was found that for 160 minutes the current curve showed the fluetube to be the cathode and the shell the anode, after which the opposite conditions existed, the fluetube being the anode and the shell the cathode, although the current was much smaller than before. About 120 minutes after the commencement of the test the heat was removed and the steam pressure was allowed to fall off, though the apparatus was not permitted to become cold. In about 315 minutes from the commencement heat was again applied, and the current quickly fell to zero, and was then reversed, the fluetube becoming once more the cathode. On the heat being again removed the current fell to zero. As to the corrosion that was noticed as a result of most of the tests, that on the fluetube was found to be similar to the corrosion found in locomotive boiler tubes, incipient pitting being noticeable along the tubes, especially in the lower portion. At the ends of the tube a marked pitting was also found.

Without referring further to the many tests described, some of the facts which they appear to have demonstrated are well worthy of attention. Of course, it may be said that the working of the small apparatus does not constitute sufficient ground on which to form a trustworthy conclusion as to what really takes place in large boilers. To take up this position, however, would, we think, be unwise. Much valuable information is often gained from such small experimental appliances, and, at any rate, the experiments we have described are worthy of very careful attention and of extended repetition. They, at least, demonstrate the possibility of marked electrolytic action. They also show that repeated heating and cooling promotes corrosion, which is also greatly influenced by the quality of the water and scale-preventing compounds used. Now if differences of temperature are responsible for a large portion of boiler corrosion, as the experiments seem to show, the problem would be largely an electrical one. How is this electrolytic action to be prevented? Largely, no doubt, by the use of pure water, but not altogether, because, so long as the water is a conductor, so long shall we have electric currents formed, unless some other means can be found of preventing them. Even distilled water has some conductivity. If it were possible to prevent the heated parts of a boiler from making metallic contact with those parts that are not heated, a cure for corrosion might be found; but there seems to be no prospect of this. Under existing conditions it is doubtful whether anything more can be done than a reduction of electric currents to a minimum by careful attention to the composition of the water; and the experiments to which we have alluded show that a certain amount of control can be introduced in this way, even to the reversal of the currents. Again, and this is a point to which Prof. Burgess calls attention, it may be possible so to distribute the electromotive forces that the electric current is made to flow in such a direction that the more vital parts of the boiler may be protected. This has, of course, been done by the use of zinc; but this metal being rather costly, many boiler owners are reluctant to use it. The oxide formed by the decomposition of the zinc is also said to be an objection on account of its harmful effects as a scale-forming material. As a substitute it has been suggested to employ some other anode which will not have the disadvantages of zinc, such as an iron bar made to take the place of one of the tubes in a locomotive boiler, and insulated from the rest of the boiler by some form of packing. This bar could be made to act as the anode by means of an electric current passing through it from some external source, and would, therefore, corrode in preference to the other part of the boiler. It might be quite possible to try this method, as the expense would not be great.

In conclusion, we may say that, valuable as we consider the experiments quoted, they form but a step on the threshold of the subject, and much must yet be done before there can be any feeling of certainty with regard to the electrolytic forces at work within a boiler. Prof. Burgess has shown clearly that such forces produce the forms of corrosion met with there, but he, or some other worker, has yet to discover where the sources of these electromotive forces are actually located. When this is done, and not till then, there may be some prospect of putting a stop almost entirely to boiler corrosion.—*Engineering.*

OLD HAYSTACK BOILERS.

BY H. MAPLETHORPE.

An old haystack boiler of unusual design and very good workmanship can be found at Bentley, Staffordshire. All the vertical seams run in straight lines with each other, instead of zig-zag, as was the usual practice in bygone days. Also the plates are all bent very uniformly, and they form a very nice-shaped haystack form. Hence the name. It must have required a lot of skill and labor in building such a boiler, when we remember that there were no hydraulic presses at hand in those days; but each plate would have to be bent by hand, probably over an ordinary anvil.

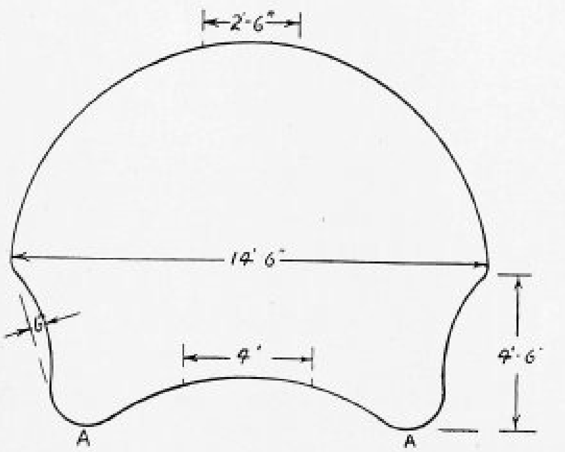


FIG. 1.

The boiler is composed of five tiers, consisting of 108 plates, there being twenty-one plates in each tier, one round plate, 30 inches diameter at the crown, and two plates forming a 4-foot circle for the crown of the fire-box. There are twenty-one plates, all nicely bent and exactly alike, to form the bottom ring (as shown in Fig. 1 at *A*), which rests on a brick foundation, and forms the furnace. The greater part of these plates have been repaired by some twenty patches. The bottom plates appear to have been ⅝ inch thick, and the sides about ⅜ inch thick. It was single-riveted, 2 inches pitch throughout; it was provided with a safety valve and a manhole. The feed water entered through a 1½-inch pipe, 3 feet from the bottom, and the water level would probably be indicated by the float stone being suspended by a wire and passing through the seating seen at the right of dome and over the sheave on top, and a balance weight would be secured at the other end of the wire. The boiler was used for many years for generating steam for driving a beam engine, such as was made by James Watt about 1784, which drove a flour mill. The engine is fitted with parallel motion, cast iron connecting rod, and a square cast iron crankshaft. The square hole in the fly-wheel is about 2 inches larger than shaft, and is wedged on fast by means of hardwood and iron wedges. The haystack-boiler has since been superseded by the well-known egg-ended boiler. Fig. 1 shows outline of boiler; there are no stays in it.

A similar boiler now stands idle at Pelsall, near Walsall. It was last used some twelve years ago as a water-tank for a locomotive, but previously, for some fifty years, was used for generating steam for winding and pumping purposes at the mine. The boiler is composed of fifty irregular shaped and size plates, and one round plate on top, 24 inches diameter. The plates are arranged in four tiers, seventeen plates being in the lower one, sixteen in the second, or middle, and thirteen on top tier; thirteen underneath forming the furnace. The boiler is about 9 feet diameter. The first row of plates is 3 feet high, the second tier is 3 feet 4 inches high, and the first row stand in 5 inches. It is single-riveted, 1¾-inch pitch, the joints are zig-zag, except three plates, where all the joints are in a straight line. There is a blow-off cock fitted near the bottom, and a 2½-inch pipe is inserted, as shown in Fig. 2; this, no doubt, being used as a float for water level. Feed-water pipe is 2 feet from bottom. The side plates are joined to the bottom plates by means of angle-iron; the boiler is very much patched, and looks as if it had done many a long day's work; and it seems a pity it should be allowed to rust away.

One of five haystack boilers which were erected in 1843 at Woodside Iron Works, Netherton, near Dudley, on the Earl of Dudley's estate, still remains. It was used for sixty years

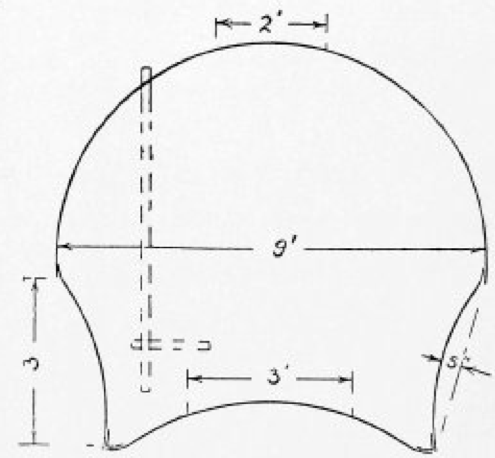


FIG. 2.

for generating steam for the well-known and famous pumping engine called "Nelson," which was erected by James Watt. It was at first fitted with a wood beam, but afterwards improved by an iron beam. This engine used to drain the mines of South Staffordshire. The boiler since 1903 has been shifted to Woodside Colliery, and at present is used as a water-tank in conjunction with a modern winding engine. The exhaust steam passes through the boiler and out of the funnel at the top. It is, therefore, very proverbially, the only haystack boiler in actual use. The boiler consists of 178 plates of irregular shape and size, arranged in eight tiers. It is about 20 feet in diameter. The first tier of plates is 4 feet high. It is single riveted; some of the joints are zig-zag, while others are straight by each other. The fire-box, which is formed like a basin turned upside down, is 4 feet high at the crown. The crown of the fire-box is composed of two semi-circular shaped plates, 5 feet in diameter. A manhole is provided. The boilers were set in brickwork, the flues running right round the first tier of plates.—*Pacific Marine Review.*

A steam separator, which can be made by any boiler maker, is described by Prof. C. H. Peabody in a recent issue of *Power and the Engineer*. The main part of the separator is a horizontal drum 3 feet in diameter and 6 feet long. Steam enters near the top at one end with an interior extension 2 feet long. The exhaust is at the top of this extension. Here the water simply falls to the bottom and the escaping steam has no chance to pick it up again.

LAYOUT OF AN IRREGULAR SPIRAL PIECE.

BY CLARENCE REYNOLDS.

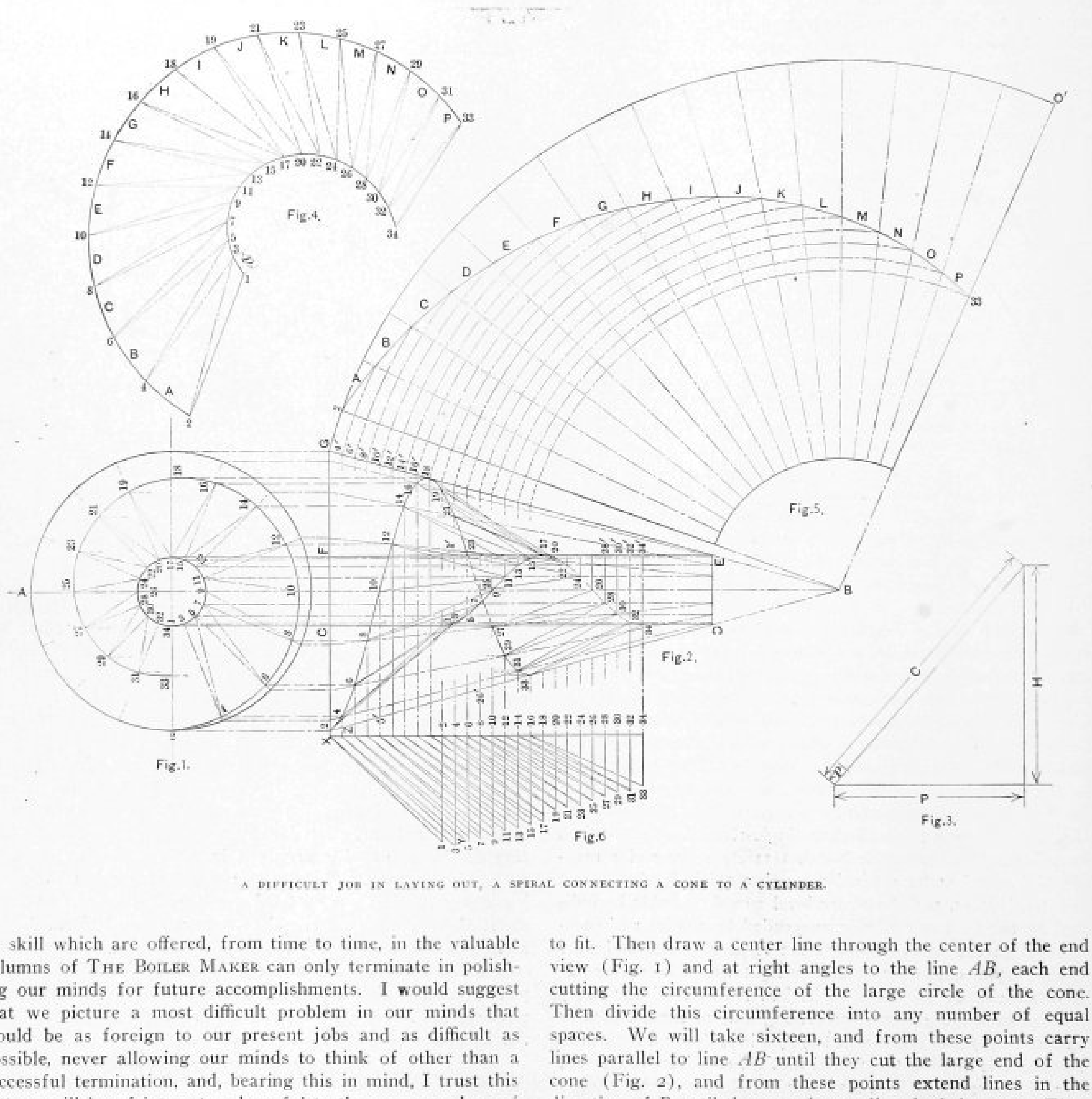
Being a close observer of the many valuable experiences offered by layers-out through the columns of The Boiler Maker, I wish to contribute something of interest in this direction. It has been my displeasure to hear many of my friends emphasize the impossibility of certain developments ever coming to practical use in our daily shop practice. Why should we burden our minds with unnecessary and unforeseen problems? It is my opinion that such thoughts should be obliterated from the minds of all layers-out. These specimens of skill which are offered, from time to time, in the valuable columns of The Boiler Maker can only terminate in polishing our minds for future accomplishments. I would suggest that we picture a most difficult problem in our minds that would be as foreign to our present jobs and as difficult as possible, never allowing our minds to think of other than a successful termination, and, bearing this in mind, I trust this pattern will be of interest and useful to the many readers of this journal.

Before a pattern for any piece of sheet metal work can be laid out, a working drawing is usually necessary. No pattern, however simple or plain, can be produced until we have something definite to work from. I mean by this, we must make a working drawing of the object as it will appear when completed. It should be made the exact size if possible, or if that is too large it can be made half size, or to any other scale. I always make my drawings either full or half size, as we are less apt to make mistakes by so doing, since every measurement taken from the half-size drawing, we readily know, must be twice that distance on our pattern.

The development of this surface appears complicated, but, if the explanation is followed very closely, it will be found very simple.

The first step is to draw the center line *AB*, shown in Figs. 1 and 2, then draw an end view (Fig. 1) and a side view (Fig. 2) of the cone and cylinder to which the spiral piece is to fit. Then draw a center line through the center of the end view (Fig. 1) and at right angles to the line *AB*, each end cutting the circumference of the large circle of the cone. Then divide this circumference into any number of equal spaces. We will take sixteen, and from these points carry lines parallel to line *AB* until they cut the large end of the cone (Fig. 2), and from these points extend lines in the direction of *B* until they cut the small end of the cone. Then in Fig. 1 draw (from the points on the circumference) lines in the direction of the center until they cut the small circle, and from these points draw lines parallel to the line *AB* until they cut the small end of the cone in Fig. 2.

Now we will draw the outline of the spiral piece. Measure from *C*, 1, then from 1 measure off the pitch 1, 34. Then



A DIFFICULT JOB IN LAYING OUT, A SPIRAL CONNECTING A CONE TO A CYLINDER.

draw the helix; the pitch 1', 34' is the same as 1, 34, except that it is on the opposite side of the cylinder and should be divided into the same number of equal spaces as the small circle in Fig. 1, then draw the corresponding lines on the cylinder as 32, 32'; 30, 30', etc. This will give the points of the helix. Connect these points together with a number of arcs and this will complete the helix, 1, 3, 5, 7, 9, etc.

The spiral 2, 4, 6, 8, 10, etc., will come next, which is drawn the same as the helix, the pitch 2, 33 is divided into the same number of equal spaces, and from these points parallel to 2, *G* and cutting the corresponding lines on the cone, connect these points with a number of arcs. To draw the spiral in Fig. 1, draw lines parallel to *AB* from the points just located (4, 6, 8, 10, etc.) in Fig. 2, cutting the lines that were drawn from the circumference in the direction of the center, we find we can get all the points of the spiral except 10 and 25, which can be taken from Fig. 2, 25 and 26' are equal to 25 and 26 in Fig. 1, and 5' and 10, Fig. 2, are equal to 5 and 10 in Fig. 1; then connect these points of the spiral with a number of arcs, this completes the spiral in Fig. 1. Then from these points on the spiral draw the triangles, as shown by connecting the points 2, 3; 4, 5, etc. Find the length of the helix and divide this length into sixteen equal spaces; this is done as follows:

Let d = diameter of cylinder,
$\pi = 3.1416$,
P = pitch of helix,
C = length of helix,
D = diameter at big end of cone;

Then $p = \sqrt{(d\,\pi)^2 + P^2} \div 16$ in Fig. 3.
$H = d\,\pi$,
p in Fig. 3 is equal to p in Fig. 4.

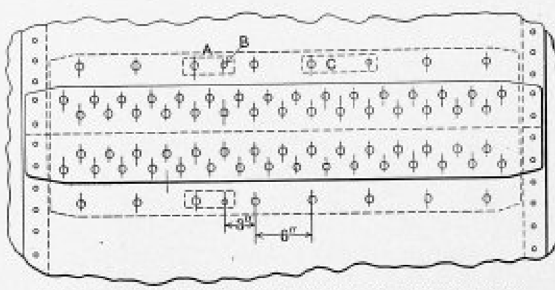
We will now find the lengths of the spaces *A*, *B*, *C*, etc., in Fig. 4; first draw lines parallel to 2, *G*, Fig. 2, from the points 4, 6, 8, 10, 12, etc., cutting the side of the cone *GE*. From *B* as a center and *GB* as a radius describe the arc 2, *o'*, Fig. 5. The length of arc, 2, $o' = D\pi$; divide this arc into sixteen equal spaces and from these points draw lines in the direction of *B*, cutting the stretch-out of the small end of the cone; then with *B* as a center, and *B* 4' as a radius, strike an arc, cutting the corresponding line in Fig. 5, likewise with *B* as a center and *B*6' as a radius, and so on until we have got all the spaces *A*, *B*, *C*, *D*, etc. These spaces in Fig. 5 are equal to the spaces *A*, *B*, *C*, *D*, etc., in Fig. 4. Now we are ready to find the true lengths of the lines in the several triangles in Fig. 1; the length of the lines, as shown, 1, 2; 2, 3; etc., are the bases of a number of right-angle triangles whose altitude is projected from Fig. 2 to Fig. 6. The bases of these right-angle triangles in Fig. 1 are transferred to Fig. 6, as shown, 1 to 2, 3 to 4, etc., inclined lines drawn from the ends of these base lines to the apex of these triangles are the true lengths of lines to be used in Fig. 4; to make this more clear, 1, 2 is the base line, of which *x* is the apex, and so on.

To develop the spiral piece from the dimensions just obtained, proceed as follows: At any convenient place draw the straight line 1, 2 (Fig. 4); in length equal to 1, *x* (Fig. 6); set the dividers to the space *p* (Fig. 3) and strike an arc in the direction of 3 (Fig. 4), using 1 as a center; strike another arc with a radius equal to 3, *x* in Fig. 6, cutting the arc just made, then, with 3 as a center and *Y Z* (Fig. 6) as a radius strike an arc in the direction of 4, using 2 as a center and the space *A* as a radius, cut the arc just made, and so on until the spiral piece is complete. You will understand the inclined lines in Fig. 6 are the length of the corresponding lines in Fig. 4, and the space *p* in Fig. 3 and 4 is one-sixteenth of *C* in Fig. 3.

A Question of Efficiency.

One of our readers has sent us the following information regarding a debatable point in boiler construction, which he considers may be of benefit to others.

The foreman of a large boiler shop in the Middle West, where a large number of tubular boilers are constructed every year, stated that he had just completed five 66 inches by 16 feet tubular boilers, which were constructed with a triple-riveted, double-strapped butt joint, maximum pitch of rivets 6 inches, and efficiency of joint supposed to be 84 percent. The boiler is braced above the tubes with patent braces, the palms being riveted to the shell with two rivets pitched 3 inches apart. The braces are so located that some of them must be located on the riveted joint, and this led to placing an additional rivet in the outer row of rivets of the joint,



SKETCH SHOWING LOCATION OF BRACES IN RIVETED JOINT.

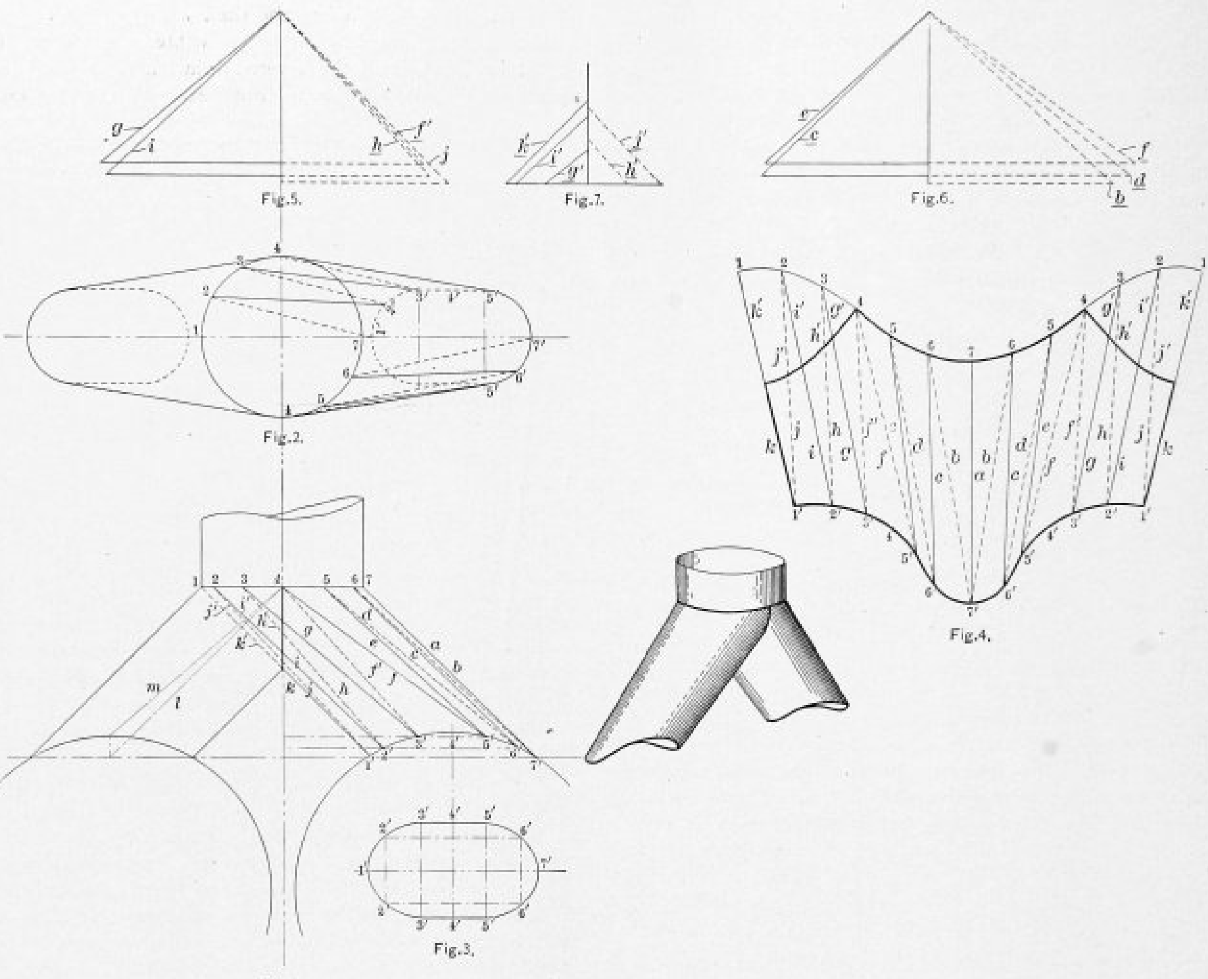
as shown in the sketch at *A*. By so doing, the pitch in the outer row of rivets is only 3 inches where the brace is attached, whereas the maximum pitch of rivets in the joint is 6 inches. As 15/16-inch rivet holes were used, the efficiency of the joint using the maximum pitch of 6 inches is 84.3 percent, whereas the net section of plate in a pitch of 3 inches where the brace is attached is only 68.75 percent.

These boilers were inspected by a substitute inspector, who was taking the place of the regular inspector, who was away on his vacation. The substitute inspector ruled that placing an extra rivet, *B*, in the outer row of rivets of the joint made the maximum pitch only 3 inches, and that instead of using a short arm, as shown at *A*, necessitating the extra rivet, *B*, a long palm, as shown at *C*, should have been used.

The foreman stated that this company has been constructing boilers from these same templates for the past five years, and no mishap has taken place. Our correspondent's opinion is that the ruling of the inspector is correct, since a chain is no stronger than its weakest link, and that the efficiency of the joint should be figured as 68.75 percent, instead of 84.3 percent, for which it was designed.

Locomotive Boiler Explosions in England and America Compared.

Commenting on the abstract of a report presented before the Master Mechanics' Association, which was published on page 304 of our October issue, one of our subscribers has sent us some statistics covering the number of locomotive boilers in use in England, the number of explosions which occur yearly, and the number of persons killed and injured thereby. It will be recalled that in the report before the Master Mechanics' Association it was stated that 7,711 boiler explosions took place on 157 railroads owning and operating 43,787 locomotives, which, it was stated, represents about 75 percent of all the locomotive boilers in the United States. In the United Kingdom there are 22,739 locomotive boilers, which is approximately one-half the number owned and operated by the 157 American railroads mentioned, and during the five-year period ending 1909 the total number of explosions of locomotive boilers in the United Kingdom was only 47, resulting in the death of four persons and injury to 43 others. The 7,711 boiler explosions which took place in the United States in the same period of time resulted in the death of 184 persons and injury to 305 others. Even considering the fact that these figures cover twice as many boilers in the United States as in the United Kingdom, the proportion of explosions and fatalities resulting therefrom indicates that either the construction, maintenance or operation of American locomotive boilers is far below the standard in Great Britain.



LAYOUT OF A Y-BREECHING WITH A CURVED BASE.

AN OLD PROBLEM IN A NEW LIGHT.

BY I. R. MILLER.

There are a number of ways in which a Y-breeching may be developed, several of which have appeared in THE BOILER MAKER. The following problem, however, has come to my attention, and I felt that it possessed several features that are new and of interest. Possibly the most interesting feature is that, unlike the ordinary Y-breeching, whose base is on a plane, it conforms to the radius of the boilers to which it is connected. This complicates the problem somewhat, yet the simplicity employed in developing the patterns makes it a very simple one.

The center line of either branch of the breeching in the ordinary Y-breeching is parallel with its sides, as indicated by the line *l* (Fig. 1), while in this problem it is not parallel, as indicated by the center line *m* (Fig. 1).

Another departure in the development of this problem, unlike the ordinary breeching having a flat base, is that in securing the data to obtain the true length of the lines used in the triangulation the altitude of the triangles varies according to the intersecting points made in the arc of the boiler to which they connect. Similarly with the spaces 1′, 2′, 3′, etc. (Fig. 4), their length having been secured by developing the hole in the boiler to which the breeching is attached, as shown in Fig. 3, thereby obtaining their true length.

To develop the pattern, draw up the side elevation (Fig. 1) and the top view (Fig. 2). Divide two of the opposite quadrants of the top circle into an equal number and as many spaces as desired, which in this case is three, numbering the division lines so made 1, 2, 3, 4, 5, 6 and 7. Since the object to be developed is symmetrical on both halves it is, therefore, only necessary to divide a semi-circle, and this is best done by dividing opposite quadrants, as shown in the top view (Fig. 2), for by so doing the lines connecting the points 1, 2, 3 and 4 with the points 1′, 2′, 3′ and 4′ do not cross the lines connecting the points 4, 5, 6 and 7 with the points 5′, 6′ and 7′. Lines crossing one another are at the best very confusing to the layerout, and are often the cause of errors; the tendency toward complicating a profile should be avoided as much as posible.

Triangulation in most problems requires a fast rule that the bottom base of an object should be divided into the same number of spaces as the top base. This, however, is not the case in this problem, as will be noted in the division points made on the quadrants (Fig. 2), they having been divided into but two spaces 1' to 2' and 2' to 3' in one quadrant, and 5' to 6' and 6' to 7' in the other quadrant. Although the bottom base could be divided into the same number of spaces as the top base by using point 4', this is not essential, as the line between the points 3' and 5' is a straight line.

To obtain the true length of the triangles for developing the pattern, proceed in the usual manner, as shown in Figs. 5 and 6, by taking the length of the lines as shown in the top view (Fig. 2) as the base of the triangles, the altitude being the height perpendicularly from the top base to the points made by the lines intersecting the arc of the lower base.

The triangles shown in Figs. 5 and 6 represent in each case the true lengths of the lines composing one quadrant of the top view (Fig. 2). This is done for the sake of simplicity and making the problem as little confusing as possible; though, if desired, and it is not convenient to construct the triangles separately, they may all be built about one altitude.

To lay out the pattern (Fig. 4), draw the line *a* equal to the length of the line from 7 to 7' (Fig. 1). From point 7 (Fig. 4) scribe an arc on each side, the length of the arc being equal to the spaces in the top base (Fig. 2). Set a tramel equal to the line *b* (Fig. 6), and from the point 7' (Fig. 4) scribe an arc, cutting the arc previously drawn, thus locating point 6. Connect 6 and 7' with a dotted line, as shown. From the point 7' scribe an arc with a pair of dividers set equal to the distance between points 6' to 7' (Fig. 3). From the point 6 (Fig. 4), with a tramel set equal to the line *c* (Fig. 6), scribe an arc, cutting the arc previously drawn from 7', thus locating the point 6'. Proceed in this manner, care being taken that the distances between the points 1, 2, 3, 4, etc., are all equal and the same as in Fig. 2. The spaces between the points 1', 2', 3', etc., should be taken from the same points represented in the development of the hole for the bushing, as shown in Fig. 3. Point 4' (Fig. 4), it will be noticed, has been skipped, and, as before mentioned, this being a flat surface between the points 3' and 5', it is not necessary to take this in account. In laying out the pattern from point 5' (Fig. 4) set the dividers equal to the points 3' to 5' (Fig. 3), and scribe an arc. From the point 4 scribe an arc equal to the length of the line *f'* (Fig. 5), cutting the arc previously drawn at the point 3' (Fig. 4). From this point proceed with the developing until the points 1, 1' have been found and the line *k* drawn.

This completes the layout of the branches for the Y, except that the intersection of the two branches, as shown in Fig. 1, has not been considered. This intersection makes it necessary to cut off the two corners of the pattern, as shown in Fig. 4.

To develop these corners it is necessary to find first the true distances from the points 1, 2, 3 and 4 on the lines *k'*, *j'*, *i'*, *h'* and *g'* (Fig. 4). To obtain this data, proceed the same as when obtaining the true length of the lines *a*, *b*, *c*, etc., by taking the length of the lines from the points 1, 2 and 3 to their intersection points with the center line 4 (Fig. 2) as the bases of the triangles. The altitude of the triangles is measured from the point 4 (Fig. 1) to the intersection points made by the lines *g'*, *h*, *i*, *j* and *k*, in the parting line of the two branches.

Having obtained the length of the base and altitude for the several triangles, draw the hypotenuses *g*, *h*, *i*, *j*, *k*, as shown in Fig. 7. With a pair of dividers or tramels scribe arcs from the points 1, 2 and 3 (Fig. 4) on the lines *g*, *h*, *i*, *j* and *k*, equal to the length of the lines found in Fig. 7. Connect the points so scribed by the irregular curve, which is the line the pattern should be cut to, that the two branches of the Y may intersect properly, thereby completing the pattern, with the exception of allowance for laps being made which should be added.

Boiler Manufacturers' Convention.

(Continued from page 329.)

Ill.; Mrs. E. J. Murray, Chicago, Ill.; John J. Main, Polson Iron Works, Toronto, Canada; Herman Memholtz, Heine Safety Boiler Works, St. Louis, Mo.; Osborn Monnett, "Power & The Engineer," New York; Jas. A. McKeown, O'Brien Boiler Works, St. Louis, Mo.; J. D. McRae, Schultz-Knaudt Company, Oswego, N. Y.; A. T. McGregor, A. M. Castle & Company, Chicago, Ill.; H. D. MacKinnon, MacKinnon Boiler & Manufacturing Company, Bay City, Mich.; Mrs. H. D. MacKinnon, Bay City, Mich.; Frank J. O'Brien, Kirby Equipment Company, Chicago, Ill.; B. W. Pierce, Jos. T. Ryerson & Son, Chicago, Ill.; E. C. Pachaly, Fidelity & Casualty Company, New York; T. M. Rees, James Rees & Sons Company, Pittsburg, Pa.; Mrs. T. M. Rees, Pittsburg, Pa.; Arthur L. Rice, practical engineer, Chicago, Ill.; Edward A. Rumley, M. Rumley Company, La Porte, Ind.; George N. Riley, National Tube Company, Pittsburg, Pa.; Mrs. George N. Riley, Pittsburg, Pa.; M. A. Ryan, Duluth, Minn.; George E. Sevey, Otis Steel Company, Ltd., Cleveland, Ohio; A. F. Spry, Maine Boiler Works, Toledo, Ohio; C. L. Thompson, Clifton Hotel, Niagara Falls, N. Y.; C. M. Tudor, Tudor Boiler Works, Cincinnati, Ohio; Wm. M. Taylor, Chandler & Taylor Company, Indianapolis, Ind.; Otto C. Voss, Allis-Chalmers Company, Chicago, Ill.; H. L. Williamson, Chicago, Ill.; C. F. Wilson, Wickes Brothers, Saginaw, Mich.; Chas. J. Wangler, Wangler Boiler Works, St. Louis, Mo.; A. J. Williams, Parkesburg Iron Company, Parkesburg, Pa.; Mrs. A. J. Williams, Parkesburg, Pa.

Boiler Feed Check Valves.

Probably the majority of people in charge of steam plants have at one time or another heard that peculiar cracking sound from main feed pipes after the plant is shut down; that is a sure sign of leaky "checks." When a set of boilers were opened up recently for their annual survey a remedy for the above defect came to light. It may be an old device, but new to some. At any rate it is extremely ingenious. A series of diagonal grooves had been filed in the rim of the valve, causing it to turn slightly with every stroke of the pump, the valve thus grinding itself automatically. The boilers in question were eighteen years old, and opened up remarkably well, showing that they had been in good hands. On the engineer being questioned, he confessed to having had a great deal of trouble with this particular valve, finding it impossible to keep it tight for any length of time. Since the alteration, however, the trouble had disappeared, and certainly the condition of the valve and seat when seen was all that could be desired. An improvement on the above idea suggests itself: to cast the wings diagonally when making a new valve which would produce the same effect, and might perhaps be more certain in action.

Changes in Massachusetts Boiler Rules.

A hearing will be held on November 3, before the Massachusetts Board of Boiler Rules, to consider a petition presented by a committee of five appointed by the Boiler Manufacturers of the State of Massachusetts. This is to consider certain changes in the present boiler rules, principally in those relating to the suspension type of setting, bracing around manholes, placing manholes in front heads, tensile strength and chemical properties of materials, hydrostatic pressure, angle braces, feed pipe and method of heating feedwater.

The Boiler Maker

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CIRCULATION STATEMENT.

Our aim in circulation is quality, not quantity. We guarantee that we have subscribers in nearly all of the railway, contract and marine boiler shops in North America, as well as in many of the leading boiler shops in other parts of the world, and that nearly every subscriber is either an owner, manager, superintendent, foreman or layer-out. Our subscription books are always open for inspection.

NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Oxy-Acetylene Welding.

Although it is only a comparatively short time since oxy-acetylene welding was first mentioned in our columns, yet since that time the art of welding by this process has progressed to such an extent that it is now one of the most important shop operations in a modern up-to-date boiler shop, and, as such, it should be given careful attention. There is no field where the opportunities for using this process is greater than in the boiler shop. At the same time, there is no field where its application is more difficult. The best and most reliable work is none too good when it comes to the manufacture of steam boilers. The most appalling disasters can result from even insignificant defects, and the only way in which safety can be insured is by so constructing each part of the boiler that its strength can be exactly determined, and its condition thoroughly examined from time to time for any tendency to failure. One can feel comparatively safe if he knows that any defect can be detected either by thorough inspection of the boiler, or by some form of test which will indicate weakness if any exists. The greatest danger lies in some form of construction which appears perfectly sound and strong even to the experienced eye of the inspector, but which, at the same time, may conceal some element of weakness which cannot be detected. Parts of steam boilers which have been joined together by welding and which are subject to tensile strength are in this latter class. The strength of a weld is always somewhat uncertain, since it depends very largely upon the care and skill with which the weld is made, as well as upon the quality of the metal which is welded, and it is this element of uncertainty regarding the strength of welded pieces which makes many boiler makers hesitate to adopt the autogenous method of welding for boiler work. Autogenous welding is really a process of localized casting, and, consequently, the material in the weld can never have the same strength or ductility as the rolled or hammered steel which is used for boiler plate, braces, staybolts and tubes. With such conditions to be met, oxy-acetylene welding can be accepted only when it is performed by skillful and experienced workmen, and when the best of apparatus is used. The fact that some boiler makers have given the process a trial and failed to make a success of it only emphasizes more strongly the fact that the art of autogenous welding can only be mastered by gradual development. It requires skilled labor, and it is evident that if a man is able to do this work successfully his services will be more valuable to his employer. Therefore, every boiler maker who desires to advance should heed the signs of the times and take advantage of every opportunity which is offered to become proficient in this kind of work. It is an opportunity where skill and good judgment will count, and apparently in the near future there will be ample opportunity to put in practice such knowledge.

The Hydrostatic Test.

At the Boiler Manufacturers' Convention last month, General Uhler, Supervising Inspector of the Steamboat Inspection Service, deplored the use of the hydrostatic test, particularly for boilers built of light material. He stated that he was in favor of discarding the test altogether on boilers where the material ranged from ⅜ inch to ¾ inch thickness, because a hydrostatic test of 150 percent of the working pressure would stress such material very close to the elastic limit, leaving the material in poor condition to withstand the varying stresses to which a boiler is subjected when under steam.

Opinion seems to be about equally divided regarding the usefulness of the hydrostatic test. It is required by practically all boiler rules and regulations, the amount varying from 25 to 100 percent excess over the working pressure. Applying a hydrostatic test to a boiler does not by any means approximate the conditions of stress under which a boiler will work when under steam, since the unequal expansion and contraction of different parts of the boiler introduce stresses entirely different from those due simply to internal pressure. It is probably much better to apply the hydrostatic test while the boiler is warm than while it is cold. Under proper conditions the hydrostatic test has many times shown up defects, and thus undoubtedly prevented explosions. On the other hand, as General Uhler points out, where the material is thin and the test pressure would bring the stress in the metal close to the elastic limit, it undoubtedly has a harmful effect upon the boiler and may even cause a permanent set in the metal. Some other test, which would give some indication of the strength of the boiler, but which, at the same time, would injure it in no way, would, of course, be more desirable than the hydrostatic test, but until such a test is offered we shall have to rely upon the hydrostatic test, using as good judgment as we are capable of in applying it.

COMMUNICATIONS.

How to Bend Angle Iron Rings.

EDITOR THE BOILER MAKER:

In your October issue one of your subscribers wishes to know how to bend angle iron rings and how to find the length of same. He states that he has some rings to make, 69 inches outside diameter, the bars to be 4 inches by 6 inches by ⅝ inch, with the 4-inch web of the angle turned in. The following expansion and sketches, based on the writer's experience, may assist your correspondent in getting out this work:

Make a former, in this case 67¾ inches diameter, as the thickness of metal comes into the diameter twice and deducting twice ⅝ inch makes the former 67¾ inches diameter. Allow for shrinkage on your pattern.

This is the best way to bend an angle that I have ever seen, and I have seen men trying unsuccessfully to bend them in many other ways.

The former is a ring, 4 inches by 6 inches, with a cross-bar across the center, about 5 inches by 1½ inches. This bar makes it convenient to attach a lever and a wheel to the lever. This bar or lever should be 5 inches by 1½ inches, about 14 feet long, made as shown in the sketch. It will be noted that there is a space between the former and the wheel of 4 inches. This is to give it a leverage on the angle, a lead so as to bend it easier; if it has 5 inches it is better and bends easier; then, when you come to the end of the angle, use a wedge between the wheel and the angle. If you have an angle on another former, somewhat smaller or larger, the position of the wheel on the long lever bar can be moved to suit. If you want to bend an angle to another diameter you must have another former of the right size, especially if there is too much difference in diameter. We sometimes bend on a single former angle rings varying an inch or two in diameter; then we set the angle a little when cold on a squeezer with a screw attached, as it is impossible to bend an angle exactly without some cold setting, as they are very stubborn and must be understood to be manipulated properly.

We do not weld many angles after bending, except in small sizes, we bend and butt them close together or open, as they are needed. It takes a whole lot of power to bend them, and a good furnace. We put on about five or six men and a pair of blocks and tackle attached to a convenient point, and a ¾-inch rope to pull on, then, as you bend the angle, you must have two helpers pounding the leg as it bends in order to keep out the buckle. There is a tendency for the angle to bend downwards, and as you must have a large cast block to fasten on your former to hold it, you will have to use a bar about 4 feet long, to keep the angle upward as it bends.

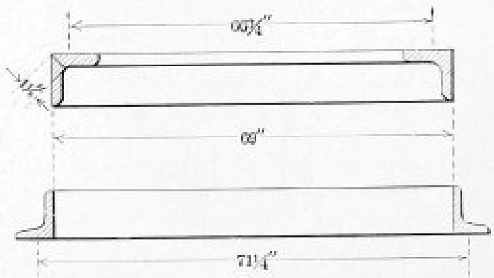


FIG. 2.

A few experiences in bending, however, will put you onto all these points.

Now, regarding the wedge which I have mentioned, you also must fasten the angle to the former with a key before bending and heat from 4 feet to 6 feet at a time. We heat about 6 feet to 8 feet, sometimes 12 feet, on a large diameter and light angles, as we have a furnace in which we can heat light angles 14 feet long.

First get a fastening to your block to hold the key, then key to hold the angle to the former to get a start. At the last of the angle use a wedge, as shown in Fig. 4. This pushes the angle up to the former at the finish, so as not to batter it too much with the sledge. We take a special heat to do this sometimes.

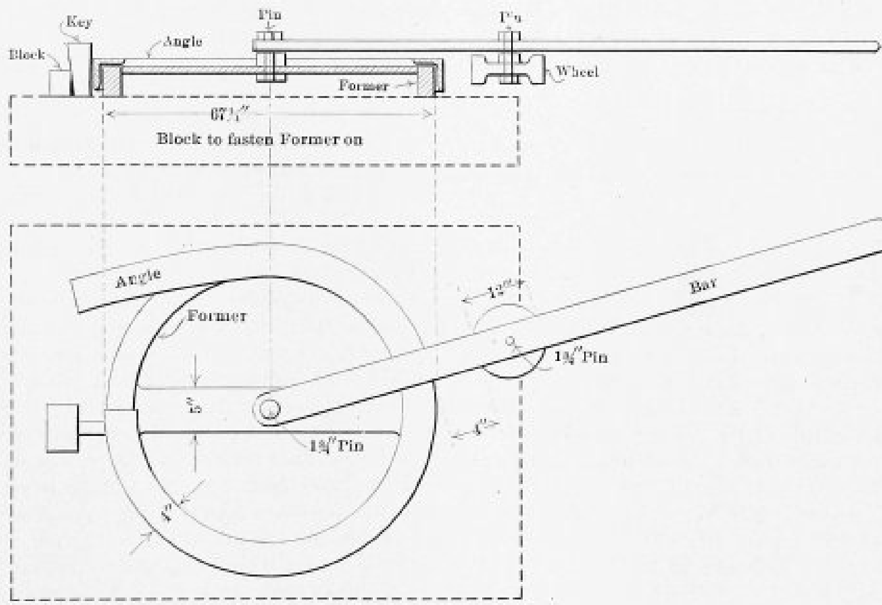


FIG. 1.

The foregoing is the way we bend angle rings, but, of course, if a man only has a few angles to bend it would be to his advanatage to have the work done at some shop where they make a specialty of this work, as it is costly at the best, and if men have had no experience some one must pay for this. We frequently bend rings for others just to help out.

To find the length, the following is the only way that we have found to be correct: First, with the leg bent in, take

69 inches minus the distance through the fillet. In this case the fillet is about 1⅛ × 2 = 2¼. 69 − 2¼ = 66¾.

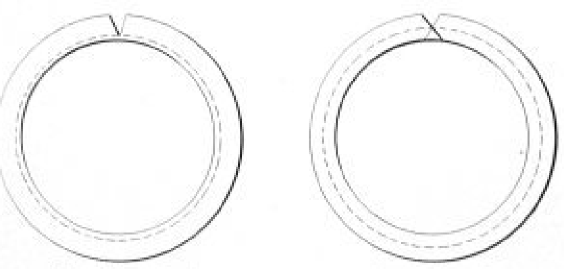
66¾ × 3.1416 = 209.70 inches.

If the leg was bent out then it would be:

69 + 2½ = 71¼

71¼ × 3.1416 = 223.84 inches.

Therefore, with the leg bent in the length would be 16 feet 6 11/16 inches; and with the leg bent out 18 feet 5⅞



Angle Bent Out Angle Bent In

FIG. 3.

inches. Now this is all right, but in bending, the last quarters of the angle do not pull right or bend as they ought to, and we have to make an allowance. As shown in Fig. 3, as the angle is bent around, an opening is left. We must allow for this, and the writer has found that it is best, if the leg is 4 inches wide, to add 4 inches extra when the leg is bent outward. If the leg is 6 inches wide add 6 inches extra. This will give you plenty to cut, so as to get a full leaf on the angle to the outside.

Some might ask what the reason of this is; my reasoning is this: The angle pulls all right on the neutral line, which in this case is 1⅛ inches from the back, but if you look at it you cannot force it on this line in the last half of each

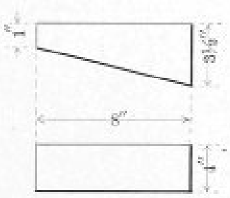


FIG. 4.

last quarter of the circle, because the ends are loose and free, and bend otherwise than the neutral line, and by experience I find that the difference is about what I have said when the leg is bent outward, but when it is bent inward the allowance is not so great; the inside leg will lap, but the outside leg will be a little short, and to make sure I would add half of the width of the leg.

Six-inch leg bent in then will take 16 feet 6 11/16 inches + 3 inches = 16 feet 9 11/16 inches.

Six-inch leg bent out then will take 18 feet 5⅞ inches + 6 inches = 18 feet 11⅞ inches.

Massilon, Ohio. Robert M. Reay.

A Word from Old Mexico.

Editor The Boiler Maker:

I have subscribed for The Boiler Maker for several years and am well pleased with it. I have learned many little points that I have made use of in my daily work at this shop, or rather round-house. I have charge of sixty-five locomotive boilers, eight classes of boilers in all. I do light repairing, such as renewing flues, patching; in fact, everything except renewing fire-boxes. I have many chances to watch the results of different ways of putting in flues to get best results, as I have full swing as to how I keep up my boilers and no one interferes with me. The only way that gives me the best results is as follows:

Get your flues out of the boiler without bruising the flue holes with the tools or with unnecessary tugging at tight flues, then clean the flue holes thoroughly. I get good coppers, No. 16 gage if possible. The older the sheet the larger the copper ferrules must be. Roll them snugly in the flue holes. I find that using annealed coppers gives me very poor service and I try to get the factory coppers and roll them, which makes them harder and smoother. The swedge I use is straight for ⅞ inch and then gradually tapers for two inches, so I have no shoulder on the flue. I swedge the flues to a snug fit. Enter the flues and slightly mandrel them, to be sure they are tight, and then expand reasonably hard with a long stroke hammer and then roll reasonably hard; not too hard. Turn over the flues with a long stroke hammer and bead them. When beading I make the boilermaker hold the air hammer toward the center, so when they are calking they are not calking straight at the flue. When expanding I work both sides and the top and work toward the bottom. I believe it makes no difference how you expand, just so long as you do not expand the outer rows last. I allow a short 3/16 inch for bead. I have Mexicans working for me; and they are not the best of workmen, for they must be watched in whatever they do.

Five divisions run to this point and every division has a different kind of water, so I have to work my engines accordingly. One division in particular has very bad water and also goes up a mountain over a 2 percent grade. These engines are Baldwin compounds with wide fire-boxes and carry 200 pounds working pressure. They have 360 2-inch flues and burn bad Chili coal. The limit for these flues is six months and no failures. When I first came here, four years ago, two to three months with many failures was the rule. When I ran them up to six months and took off the water car we found it paid to renew flues and save costly failures. This water forms a scale, which is very hard, and when it breaks off and gets lodged between the flues all the soft mud lodges on top and works toward the point where the flues leak and then we have loose flues. It takes four to five months for them to get in this condition. I renew a few, but it makes the others leak worse.

I use the expander on old flues, and not too much of that, and never a roller, except the last few trips before shopping. These engines make two trips in twenty-four hours, it being six hours up and two hours down. I use very few flue plugs. I believe in keeping the flues open as much as possible, as an engine needs all the steam it can get. I wash these boilers thoroughly three times every week. The boilers in the other divisions vary from fourteen months to eighteen months, and then the flues are renewed only on account of mud accumulation on the crown sheets and ogee of a Belpaire type of boiler. Before coming under my management the limit for flues was five and six months, the flues were plugged, the crown sheets were mud-burned and the side sheets were mud-burned. Also the engines were not properly drafted in the front ends. Other types were in same condition.

D. L. Akers,

Boiler Foreman, National Railways of Mexico.

Cutting-off Tool Wanted.

Editor The Boiler Maker:

Can you or any of your subscribers advise us of an efficient tool for cutting-off and flaring boiler tubes? Our practice in tubing boilers is to have the tubes placed in the boiler and set so that they are the right length for beading on one end, leaving the other end generally a little too long. This extra metal is then trimmed off either by hand or by some form of cutting tool, working from the inside of the tube feeding in. This tool also flares the end of the tube so as to put it in good condition to bead. We have been using a tool for this purpose made by a well-known boiler tool manufacturer, but it is so delicate in its construction that the up-keep is very heavy, and we wish to find one which is more durable in design. We should appreciate any information which readers of THE BOILER MAKER could give us through your columns regarding such a tool.

BOILER MANUFACTURER.

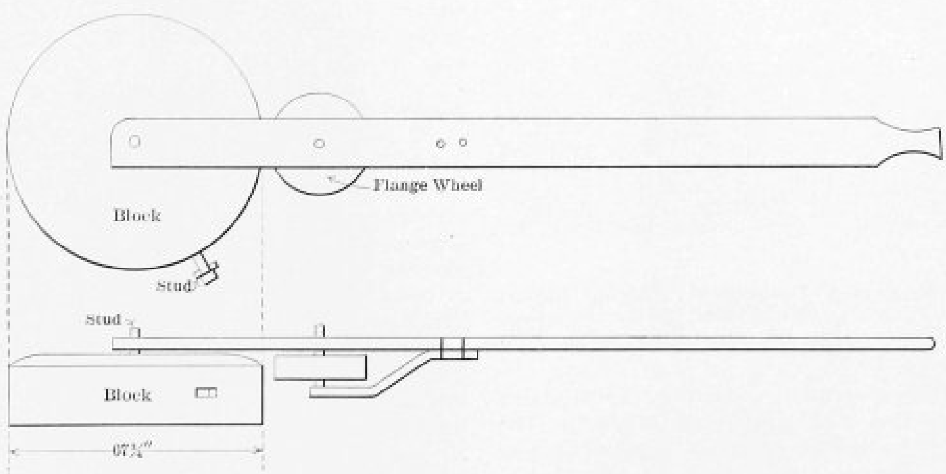
How to Bend Angle Iron Rings.

EDITOR THE BOILER MAKER:

I notice in the October issue of THE BOILER MAKER that a subscriber wishes to know how to bend angle iron on a sectional flanger. This is a trick which I should also like to learn. The following, however, is the method by which I have been taught to bend angle iron rings of the size which your correspondent mentions:

Have the molders make a block 67¾ inches in diameter and 7 inches high; put a stud in the center of the block, 1¼ inches by 3½ inches; also put a stud in the side of the block on which the angle iron can be clamped by slipping a dog over it; next take a bar of iron, 4 inches by 1 inch by 12 feet long, and put a 1⅜-inch hole in the end of it to fit over the stud in the top of the flange block; rivet on a strap, as shown in the sketch, to help hold the bending wheel; set this wheel so it will come about 1/16 inch outside the thickness of the angle iron from the block. The wheel should be the same size as the iron which you are bending, and the block should be fastened so it will not move. Two men can then bend the rings, one man operating the lever on which the flange wheel is fastened, and the other working just in front with a heavy wood maul, forcing the bar around the block. In my opinion, this method is easier than to try to make a bulldozer out of a sectional flanger, as was suggested in your October issue.

Francis, Oklahoma. J. H. KEARNS.



SKETCH OF DEVICE FOR BENDING ANGLE-IRON RINGS.

Tube Joints.

EDITOR THE BOILER MAKER:

Reading the little article entitled "Tube Joints," page 297, October issue of the paper, brings to mind an experience that I had a few years ago in retubing two National watertube boilers in a power station. Perhaps a recital of the facts would be of interest to some of your readers.

The headers into which the tube ends were expanded were of cast iron in those boilers, and because of frequent expanding the holes had become enlarged to quite an extent. After the old tubes had been cut out and everything made ready for putting in the new tubes, it was found that the tubes were much too small for the holes; but it was thought that by using the expander carefully the tubes could be gradually expanded to fill the holes. I would say here that the tubes were the best that could be obtained and were made of charcoal iron, so it seemed reasonable to expect that they could be secured in place if a little care were exercised in doing the job.

The first tube was put in place and the expander applied. Just as we were about to congratulate ourselves that we would succeed in making a good, tight job, crack went the tube end, much to our disgust. The crack extended from the extreme end of the tube, which protruded from the outside of the header, about one-half inch beyond the seat against which the end was expanded, and so rendered that end useless; in fact, the whole tube had to be taken out and cast aside.

It was thought at the time that an imperfection might have existed in that one tube, because of it having cracked just about the time it was making fast to its seat. It was suggested that another tube be tried, but that the ends be annealed in a charcoal fire and expanded while yet hot, so as to give the metal every chance to expand without cracking. This was tried, and it looked as though we were going to be successful this time, when, crack again went the end. It seemed strange that the crack occurred after the end had just been made fast, and once more around with the expander would have finished the job on that end of the tube. As this was the second tube that had been ruined as far as our boilers were concerned, we decided to put in a "dutchman" around each end to fill up the space between the tube and the seat. Strips of 1/16 inch sheet iron were cut in lengths a little in excess of the outside circumference of the tube, and a little wider than the width of the seat; and then the ends were hammered, tapered, so as to overlap and make the circle continuous. These were inserted and the tubes expanded without any trouble whatever, and not one leaked when subjected to 160 pounds per square inch water pressure.

We carried 100 pounds per square inch steam pressure on those boilers, and by properly handling them we did not have any occasion to expand any of those tubes for a long while. They never showed any signs of becoming loose, although we continued to watch them closely every time the boilers were cut out of service for cleaning and overhauling.

Scranton, Pa. CHARLES J. MASON.

TECHNICAL PUBLICATIONS.

Hendricks' Commercial Register of the United States (Buyers and Sellers). Size, 7½ by 10 inches. Pages, 1,342. New York, 1910: Samuel E. Hendricks Company. Price, $10.

The 19th annual Revised Edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. It is by far the most complete edition of this work so far published. The 18th edition required 87 pages to index its contents, while the 19th edition requires just 100 pages, or 13 additional pages. As there are upwards of 400 classifications on each page, the 13 additional pages represent the manufacturers of over 5,000 articles, none of which has appeared in any previous edition. The total number of classifications in the book is 35,481, each representing some machine tool specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries. The 18th edition numbered 1,222 pages, while the 19th edition numbers 1,344, or 124 additional pages. One hundred and fourteen pages of matter have been omitted from the new edition that appeared in the 18th edition. This makes a total of 238 pages of new matter, the whole representing upwards of 350,000 names and addresses. An important feature of the Register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes. The value of the book for purchasing purposes is not confined to its complete classifications alone; it also gives much information following the names of thousands of firms that is of great assistance to the buyer, and saves the expense of writing to a number of firms for the particular article required. The trade names of all articles classified in the book are also included as far as they can be secured.

The Mechanical Engineers' Pocketbook. Eighth edition. By William Kent, M. E., Sc. D. Size, 4½ by 6¾ inches. Pages, 1,461. Illustrations, 218. New York, 1910: John Wiley & Sons. Price, $5 net.

Kent's *Mechanical Engineers' Pocketbook* is too well known to need any introduction to the engineering fraternity. The present edition is of exceptional importance, however, because the entire book has been rewritten, a task which has occupied the author four years. Some 350 pages have been added to the previous edition, and the text has been brought up to date and revised. Notwithstanding the large amount of new material which has been added the book has been brought within the limits of a comparatively small volume through the condensation and elision of much of the old matter and by resetting the tables in more condensed form. A new style of type has been adopted for tabulated matter, which is much more easily read than the old type.

It is hardly possible to more than mention some of the important changes which have been made in the book, since to examine critically the text would require more space than is available within the limits of this brief review.

The section relating to marine engineering has been changed very little. The figures which appeared in the older editions covering the design and performance of marine engines have been eliminated, since all of the data referred to reciprocating engines. In place of this figures covering the dimensions and performances of notable Atlantic steamers have been included; figures for practice, including the performance of both the boilers, engines and auxiliaries of ships typical of different decades in shipbuilding, have been introduced; also some data regarding the performance of the new Cunarder *Lusitania*. In the section devoted to the screw propeller, Barnaby's method for determining the best dimensions for screws of any speed and horsepower is explained, and an abridged table of data for use in connection with this method has been added.

Considerable change has been made in the section devoted to electricity. Instead of including data which would be useful solely for the electrical engineer it has been the aim of the author to make the section on electricity include only such information as a mechanical engineer should possess in order to handle electrical machinery.

The sections relating to materials, strength of materials and iron and steel have necessarily been considerably changed to conform with the latest engineering practice. Many new tables have been incorporated in these sections, and some of the older tables relating to the strength of materials have been considerably enlarged. In the section on iron and steel the most recent specifications for various grades of iron and steel are included and the new alloy steels are thoroughly discussed.

A large part of the book is devoted to power and its various applications. A new steam table, based on the work of Marks and Davis, has been calculated, dealing with both saturated and superheated steam. New sections covering steam turbines and gas engines are included; smoke prevention is given considerable attention; the problems relating to air, fans, blowers, etc., are made very complete.

The foregoing is but an indication of the many important features of the book, but engineers who are familiar with the earlier editions will realize the value and importance of this new edition.

Applied Thermodynamics. By H. W. Spangler. Size, 6 by 9 inches. Pages, 160. Illustrations, 76. Philadelphia, 1910: John Jos. McVey.

As has been the case with many text-books on engineering subjects, this book is the outgrowth of a series of lectures given at a university, in this case to the students in mechanical, electrical and chemical engineering at the University of Pennsylvania. The text relates to the applications of thermodynamics to engineering problems. The book is, therefore, not an elementary one by any means, and the author assumes that the student has some previous knowledge of elementary thermodynamics as well as higher mathematics. The contents include chapters on the flow of gases, vapors and steam; air engines; steam engines; refrigeration; internal combustion engines and evaporators. Some temperature entropy diagrams relating to the steam turbine have been introduced, which the author claims are different from anything heretofore published, and should prove valuable to engineers who have to deal with turbine machinery. The treatment of each subject is concise, but exceptionally clear; the illustrations have been well chosen and are excellent for the purpose.

Notes on Mechanical Drawing. By Horace P. Fry. Size, 6 by 9 inches. Pages, 61. Illustrations, 57. Philadelphia, 1910: Published for the University of Pennsylvania.

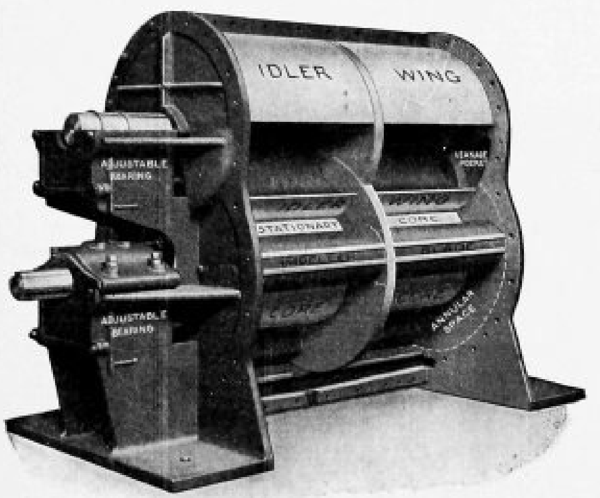
The original copy for this pamphlet was prepared by Edward R. Keller, M. E., an instructor in mechanical engineering at the University of Pennsylvania from 1890 to 1892; later editions were prepared and revised by Lucian E. Picolet, instructor in mechanical engineering, 1892 to 1902; the subsequent and current editions were prepared and revised by the author, who is now assistant professor of mechanical engineering at the university. The subject matter of the notes is not an exhaustive treatise on mechanical drawing, but it is intended to supplement class instruction. For this reason many outside students will prefer a more complete book when entering upon a thorough study of the subject; but the pamphlet is full of excellent suggestions and everything is clearly explained by the use of diagrams and illustrations. Nearly every student of mechanical drawing will find something of value in the pamphlet.

ENGINEERING SPECIALTIES.

Blower for Fuel Oil Burning.

The high-pressure blower described in this article is being successfully used in marine work for furnishing blast in connection with fuel oil burning, both on shipboard and in navy yards. It is one of the products of the B. F. Sturtevant Company, of Hyde Park, Mass., who claim for it several distinctive features both in design and construction. Although this blower is of the positive type, by its design and operation it is claimed to overcome almost entirely strong pulsations in the discharge and internal contact of the rotors, resulting in a tendency to wear out and difficulty of adjustment. The lack of pulsations in the discharge is a very important point in fuel oil burning, and in this blower the rotors never come in contact with each other or with the casing, which permits high rotative speed without endangering the blower, and consequently reduces the pulsations.

All the work is done by the impeller, which consists of three diamond-shaped blades and a central web, the hub of which is keyed to a steel shaft. This impeller operates in



the larger portion of the casing, its blades revolving around a cylindrical core consisting of two parts, one attached to either end plate, the web of the impeller revolving between them. This forms three pockets in which the air is taken from the inlet and forced over the outlet. Into the end plates are cast leakage pockets, which catch all the air leaking through the clearance spaces, and this air is again caught and carried forward by the following blade. This causes gradual compression, which in turn reduces the pulsations.

The idler does no work. It is located in the smaller part of the casing and consists of a symmetrical casting of three hollow vanes, or blades, whose periphery forms nearly a complete circle. The office of this rotor, revolving at the same speed as the impeller, is to form successively longitudinal spaces, or chambers of the proper size, to permit the impeller blades to return to the suction side of the blower without allowing the escape of the compresed air. As no work is done by the idler, the only power necessary to be transmitted by the gears is that required to move the idler at the proper speed.

Special care has been given to the design and construction of the bearings, which in the larger sizes are of the wedge block type, easily and accurately adjustable by the simple turning of a set screw. Peek holes are provided, which make adjustment possible without removing the end plates; in fact, many adjustments may be made while the machine is in operation. Oil is supplied by means of chain and ring oilers.

Unbreakable Rivet Sets.

Since the invention of the pneumatic hammer, constant trouble, expense and annoyance have been the experience of the users of these tools, due to the crystallization and consequent breakage of the rivet sets used in these tools. This breakage invariably occurs in the neck of the tool, and it is not unusual in driving large rivets for a riveting gang to break two or three sets a day. Since the introduction of alloy steels steelmakers have made great strides in the manufacture of steel that would resist the tendency to crystallize under the repeated blows of the hammer. The great trouble has been heretofore that they seemed unable to make these alloy steels with any degree of uniformity. One lot of steel would give excellent results, but the next lot would be practically worthless. Geo. F. Marchant, Chicago, Ill., claims, however, to have succeeded during the past year in obtaining a vanadium alloy steel that is not only uniform in quality, but has shown remarkable results when made into rivet sets and properly heat treated. To cite an instance of the remarkable durability of the vanadium sets, two of them were put to work by the Strobel Steel Construction Company on the new Northwestern station in Chicago in February. They have been in constant use since that time and, it is estimated, have driven more than 25,000 ⅞-inch rivets, and are apparently in as good condition now as when new. Previous to this, sets made from high-grade carbon tool steel would seldom last, especially during the cold weather, more than two or three days, and would often break during the first hour of use.

A Convenient Arch Tube Bender.

An arch tube bending device is in use at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Railroad, which consists of a cast iron sector grooved on its periphery to fit the size of tube used. A yoke, ending in a handle of proper length and carrying a grooved roller, is pivoted at the center of the sector in such manner that when a tube is inserted in the clamp at the end of the sector the swinging of the yoke through a predetermined arc causes the tube to bend to the radius of the arc. The amount of bending is fixed by the adjustment of the forked stop just to the right of the sector, and the position of the bend in the tube is determined by the position of the stop, against which the end of the tube is placed before bending. The device is mounted on a truck so that it can be brought up near the tube heating furnace when in use and trundled to some convenient out-of-the-way point when not in use.

PERSONAL.

E. R. KYLER, formerly connected with the engineering department of the Waterous Engine Works Company, Brantford, Ont., has resigned his position and is now connected with the sales staff in watertube boiler department of the Henry Vogt Machine Company, Louisville, Ky.

THOMAS WOOD, formerly general foreman of the Tulsa Sheet Iron Works, Tulsa, Okla., has accepted the position of foreman for the Quaker City Iron Works, Philadelphia, Pa.

GEORGE M. DOUGLAS, chief inspector of the Casualty Company of America since the formation of that company, and head of the boiler, fly-wheel and inspection departments of the same company since May, 1909, has severed his connection with that company. Mr. Douglas will take a much-needed rest from his recent arduous work in connection with the three departments before again engaging in business.

F. A. SCOTT, of the Rome Locomotive & Machine Works, Rome, N. Y., has been appointed foreman boiler maker of the Rutland Railroad shops at Rutland, Vt.

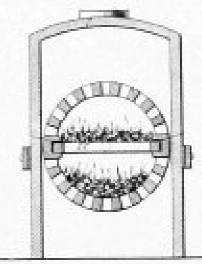
P. F. GALLAGHER, formerly at the Rutland Railroad shops, Rutland, Vt., has accepted a position with the Baltimore & Ohio Railway Company, Baltimore, Md.

SELECTED BOILER PATENTS.

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

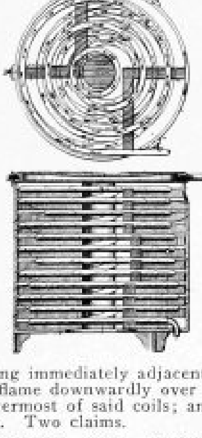
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

966,200. FURNACE. JOHN HARRIGAN, OF BROOKLYN, N. Y.
Claim 2.—A furnace having a casing provided with an exit flue and with a charging door, a chambered member arranged to turn in said casing and provided with guides at its opposite sides, and an apertured grate extended transversely through said chambered member and having



its opposite sides removably engaged with the guides at the opposite sides of said chambered member and dividing said chambered member into upper and lower fire boxes, one of which is adapted for communication with the exit flue and the other of which is adapted for communication with the charging door. Nine claims.

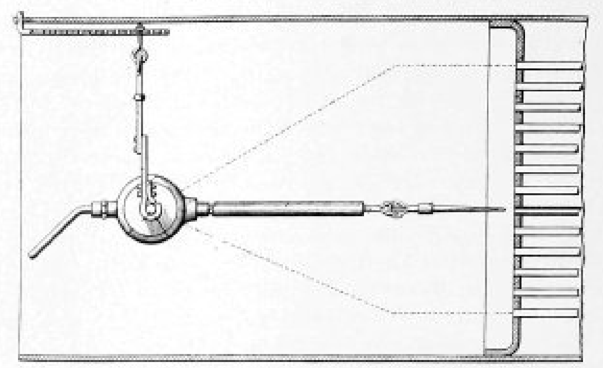
967,961. STEAM-BOILER. ALFRED A. OLSON, OF RIVERSIDE, ILL.
Claim 1.—A boiler consisting of a housing; a series of connected coils arranged therein, one above the other, the number of convolutions in said coils decreasing from the lowermost to the uppermost; a burner



at the top of said housing immediately adjacent the top of said coils and arranged to project its flame downwardly over said coils; a water supply connection with the lowermost of said coils; and a steam-pipe connection with the uppermost coil. Two claims.

967,128. WATER-GRATE AND PROTECTOR. JOHN G. B. JOHNSON, OF PINE VALLEY, MANITOBA, CANADA.
Claim.—The combination with a fire grate having spaced parallel water tubes, of V-shaped plates disposed below the tubes and coextensive therewith, the said tubes being arranged within the plates, and transverse upwardly bowed pins disposed across the open tops of the plates at intervals and resting upon the upper surfaces of the said tube whereby the said plates will be held suspended by the tubes. One claim.

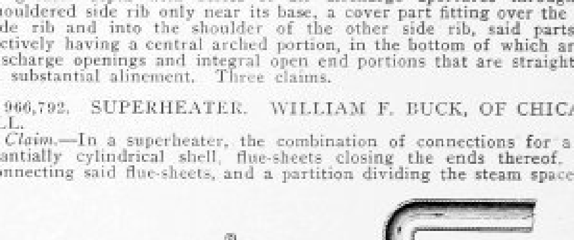
966,638. APPARATUS FOR BOILER-FLUE WORK. CARL A. ANDERSON, OF DUBOIS, PA.
Claim 2.—An apparatus of the class described, including an oscillatory motor, a tool-holding shaft, extensible members connecting the tool-holding shaft with the motor, a substantially wedge-shaped hanger having upwardly converging sides provided with straight inclined outer edges, said hanger being provided at the top with an eye connecting the sides and the latter being provided with bearings receiving the pivots of



the motor, and means connecting the sides and engaged with the inclined outer edges thereof. Seven claims.

966,680. STEAM-BOILER FURNACE. GEORGE S. GALLAGHER, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO HENRY GALLAGHER AND ONE-HALF TO EMMA G. GALLAGHER, OF NEW YORK, N. Y.
Claim 2.—In a steam boiler furnace, a hollow shell member consisting of a channel part having one plain side rib and one shouldered side rib of greater depth with series of air discharge apertures through the shouldered side rib only near its base, a cover part fitting over the plain side rib and into the shoulder of the other side rib, said parts collectively having a central arched portion, in the bottom of which are air discharge openings and integral open end portions that are straight and in substantial alinement. Three claims.

966,792. SUPERHEATER. WILLIAM F. BUCK, OF CHICAGO, ILL.
Claim.—In a superheater, the combination of connections for a substantially cylindrical shell, flue-sheets closing the ends thereof, flues connecting said flue-sheets, and a partition dividing the steam space into



two sections, said intermediate flue-sheet having a flange fitting the inner surface of said inner shell, and the joints between said inner flue-sheet and said flues being made steam tight. One claim.

966,998. BOILER-TUBE CLEANER. FRANK EFRAIM CARLSON, OF BROOKLYN, N. Y.
Claim.—In a flue-cleaning device, the combination of a conical cutter having ratchet shaped cutting edges and having integral with it a flattened portion adapted to receive a wrench, and having an angular shaped hole longitudinally through it, another ratchet shaped cutter adapted to fit against the flattened portion of the first-mentioned cutter, and having a similar angular shaped hole, a bolt having angular sides fitted to pass through the holes in the cutters and having a threaded end, and a shoulder and a driving bar secured to said threaded end and abutting against said shoulder. One claim.

967,717. INJECTOR. ROBERT GRUNDY BROOKE, OF MACCLESFIELD, ENGLAND.
Claim 1.—In a steam injector having separate main and supplementary overflow outlets, and a main overflow valve, a fluid ejecting device surrounding and in communication with the main overflow outlet between the combining and delivery nozzles and a device adapted to open and close the supplementary overflow outlet, said outlet opening and closing device being arranged wholly external to and independent of said fluid ejecting device, but capable of being moved into a position to close said supplementary overflow outlet by the action of fluid issuing from said fluid-ejecting device. Ten claims.

967,228. WATER-LEVEL CONTROLLER. EDWARD P. NOYES, OF WINCHESTER, MASS., ASSIGNOR TO C. P. POWER COMPANY, OF NEWARK, N. J., A CORPORATION OF NEW JERSEY.
Claim 1.—The combination of a vessel adapted to contain a liquid and an elastic fluid under pressure, a controller for said vessel having a septum operated by differences of pressure, means subject to a varying liquid-level for causing said pressure differences, a chamber in said controller receiving a portion of the liquid whose level varies, and liquid-level-controlled mechanism for automatically returning the liquid from said chamber to the vessel. Nineteen claims.

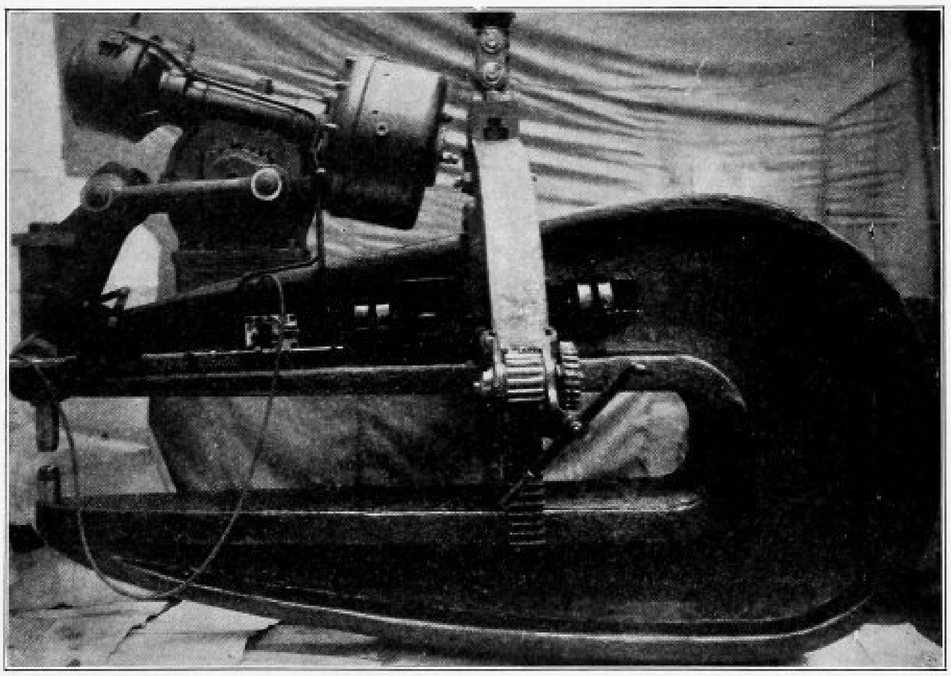
THE BOILER MAKER

DECEMBER, 1910

GERMAN FLYWHEEL ELECTRIC RIVETING MACHINES.

BY FRANK C. PERKINS.

A most unique design of electric riveting machine has been developed at Leipzig-Sellerhausen, Germany, by the Leipziger Maschinenbau-Gesellschaft, equipped with friction clutches, as well as a novel form of electro-magnetic clutch for boiler riveting. It is of interest to note that one type of this German electric riveting machine has been designed with a friction clutch, to rivet all sorts of ironwork, including rails and objects that do not require steam-tight rivets. This German machine for rivets of 1 3/16-inch has a gap of jaw of 39⅜ inches and is constructed for horizontal and vertical suspension.



ELECTRICALLY DRIVEN FLYWHEEL RIVETER.

For locomotive and boiler plants an electric riveter is utilized, having an electro-magnetic clutch so arranged that the pressure stays on the rivet as long as desired. A machine of this construction for rivets of 1 3/16 inches has a gap of jaw of 39⅜ inches and is designed for universal suspension, while a machine has been built for 1-inch rivets with a gap of jaw of 78¾ inches for horizontal and vertical suspension.

While it is true that an electric machine in itself does not represent any particular novelty, it is maintained that all the other existing arrangements have the disadvantage of the motor, running the risk of burning up in consequence of the shock and great current variations. With these German electric riveting machines the motor is moving the flywheel that accumulates the energy, and for this reason the motor is safeguarded and its burning up is said to be absolutely impossible. It is held that there is also the advantage of an extremely low current consumption and loss of power.

As seen in the illustration the machine consists of a steel casting, having on its upper part the lever mechanism, as on the pneumatic riveting machines. This lever is moved by a connecting rod, that is operated by an electromotor by means of an endless worm and a screw-wheel. The electromotor drives with its elongated shaft the flywheel and a set-bolt pulley. The movement of the lever and the cup-shaped dies is obtained by engaging and disengaging a clutch-coupling An accurately operating slide coupling is utilized for driving, so that it is moving at the maximum pressure and therefore unfailingly safeguards the machine and its parts from being damaged. In order to protect the motor from excessive overload overcharge, if the cup-shaped dies should be inaccurately fixed, there is another fuse provided.

The cost of operation, as well as the first cost, is extremely low, as the central compressor station equipment is not necessary as with pneumatic or hydraulic machines. The output is said to be enormous, as more than 200 rivets can be placed per hour, provided that the workmen are able to follow the machine with the same rapidity, putting the rivets in the holes and handling the work. This rate of 200 rivets per hour may still be increased, since a machine for 1-inch rivets makes 18 strokes a minute. Therefore the productive work of the machine is not at all limited to 200 rivets per hour.

It is claimed that in spite of this rapid work, finished rivets are obtained of most excellent quality, and in case the rivet is put into the hole properly when cutting through the rivet in a test piece, it is found to be completely welded together with the sheet.

The amount of power required is very low, a machine driving ¾-inch rivets utilizing a motor of 2 horsepower, and for 1-inch rivets one of 3.5 horsepower, with a good margin of power giving at full working a reserve of fully 50 percent. The loss of power is also said to be extremely low. With a motor of the continuous current type of 220 volts pressure it has been found that during the operation of the machine without load, only from 2 to 3 amperes were used, while during the riveting process 8 to 10 amperes were required. These results are undoubtedly of great interest and, it is claimed, cannot be attained by either the pneumatic or hydraulic system. The low demand for power of the machine is said to be due to the fact that the motor mounted on the machine does not perform instantly all of the work itself, but brings into service the flywheel and its momentum in doing the riveting work. This German system of electric riveting is said to provide absolute safety in working, as the safety coupling arranged within the flywheel moves with excessive pressure and the fuse breaks the circuit if the motor should be heavily overloaded.

Pneumatic Boiler-Tube Scaler.

There is now being manufactured in Birmingham, England, a pneumatic tube scaler designed to remove deposits on the interior of tubular boilers, so that they may give the best heating results.

This scaler consists of an oscillating pneumatic hammer of a size to permit it to pass easily through the tubes. At the end that enters are fitted six vibratory cutters, arranged in a circle around a central ram and anchored by lugs to an internal collar at the front end of the tool, the interior of the cutter circle being coned to receive the blows of the coned fore end of the piston or hammer. The device is valveless and the ram is its only moving part.

It is designed to give from 2,000 to 3,000 strokes per minute, and it is said that it can be regulated to anything within that range by the pressure of air employed; that it requires an average working pressure of 80 pounds, and that by throttling the supply the blows may be regulated to suit any particular degree of hardness or thickness of the scale.

In the process of operation the longitudinal blows of the hammer shank cause the cutters to deliver corresponding circumferential blows against the lining of scale on the interior of the tubes. The separated scale is blown ahead by the exhaust air. The tools vary in size from ¾ to 7 inches in diameter. The design of the tools varies somewhat for other uses of a similar kind.—*Daily Consular and Trade Reports.*

The R. Munroe & Sons Manufacturing Corporation, Twenty-third street, Pittsburg, has erected a new steel building, 70 by 200 feet, equipped with a 25-ton electric traveling crane, a 200-ton Wood hydraulic press for heavy flanging, punches, toggle presses, etc. This is an addition to the present building, and will be used as an erecting shop, more than doubling the present capacity.

COMBUSTION.

BY E. N. PERCY.

To understand combustion properly it is necessary to get a true conception of heat; to do this, one must have a conception of energy. It is almost impossible to bring the mind to comprehend energy, since the only things known about it are its results and effects. It is supposed to be a condition, or, possibly, an elusive substance, as yet undiscovered, radiated from the sun, and perhaps other sources. Wherever this radiation strikes, it either stores energy or manifests itself in some well-known manner. All organic growth is a storage of this energy, and such growth stops immediately that source of energy is removed. The tropics produce more organic matter than the poles, because there is more energy available. This energy having thus been stored, it may be made use of by extracting it from coal, petroleum, sulphur, various chemical substances, etc. Also, we can concentrate a great deal of energy in a small space, as dynamite or gunpowder. When these radiations strike the earth they produce heat, and heat exists only where they strike and does not come from the sun, only the radiation comes from the sun, and the intervening space is cold. This energy expresses itself in aurora borealis, electricity, light, X-ray and many other beautiful manifestations as yet only partially understood. These are all conditions and not substances; in fact, are the result of the action of energy on substances. One of these conditions is heat. Heat is a result of energy. Some say it is a form of energy, but that is incorrect, because it implies that energy is a concrete substance, whereas it is only a condition. Energy expressing itself as electricity, or light, may convert its expression into heat, or *vice versa*. When fuel is burned energy is manifest, the same energy that was previously stored. This energy expends itself upon the nearest substance, carbon, gases, furnace walls, etc. This radiation of energy is known as heat. It renders the fuel incandescent, it renders the escaping gases incandescent, and we call them flame, and the gases, furnace walls, etc., carry off the heat by means of well-known physical laws, and the phenomena are known as combustion; but the important point to note is that heat is a condition, and the escaping gases, etc., merely vehicles. Internal combustion engines utilize the heat as made by utilizing the expansion of the products of combustion; but in a steam plant the heat must be transferred from the gases to another vehicle, namely, steam. It could just as easily be transferred to ammonia, liquid air, or plain air, and an expansion engine operated just the same, but water, for many reasons, is the most practical vehicle.

Most substances can be burned chemically, that is, iron will burn like a candle in pure oxygen, oxygen will burn like a gas flame in a hydrogen atmosphere, air will burn in a gas atmosphere just the same as gas burns in air, sulphur will burn in a hydrogen atmosphere, and hydrogen will burn in a chlorine atmosphere, white hot glass will burn in hydrofluoric acid vapor, as will also sand, and the impurities in steel, as well as some of the steel itself, are burned in any of our steel works with ordinary air. For the cheap generation of heat, however, it is necessary to have a cheap fuel and a cheap atmosphere. An All-seeing Providence has provided both, and it only remains for man to use them. The well-known solid fuels range from coke through various grades of coals to lignites and asphaltum. The crude oils range from paraffine or asphaltum to light distillates, the gases from heavy hydrocarbons, hydrogens to monoxides. They all consist of nothing but hydrogen and carbon. The monoxides are really partially burned gases, which will be considered later. However, all organic matter is made largely of hydrogen and carbon, and the study of the hydrocarbons is more extended and complicated than all the rest of chemistry put together.

Combustion, as generally understood, is the oxidizing of cheap materials, consisting principally of carbon and hydrogen, with air, attended by the conditions of great heat, light and physical activity. The solid, liquid and gaseous fuels all consist of hydrogen and carbon. Some contain oxygen, but that is a non-burning constituent. Some contain sulphur, which is a burning constituent, but objectionable for other reasons.

If a fire is 6 inches deep, and burning brightly, there result products of combustion known as carbon dioxide. There is also nitrogen, but this comes from the air and passes through the fire unchanged. If now the fire be 5 or 8 feet deep, or even 2 feet, or even 1 foot, with insufficient draft, there results carbon monoxide instead of dioxide. The monoxide is a combustible gas and can be burned by admitting more air above the fire. It is on this principle that an ordinary gas producer works. Producer gas must not be confused with illuminating gas. Producer gas consists of the following constituents: Carbon monoxide, some hydrogen and 50 percent or more nitrogen; while illuminating gas consists of more than half hydrogen, no monoxide, and no nitrogen. Still another illuminating gas contains monoxide, but no nitrogen. Also, from any coal fuel bed, when coal is first fired, many volatile hydrocarbons are distilled in the form of green vapors. These can be ignited, but only with plenty of air above the fire and surrounded with hot brick. In proof of this, when the fire is freshly charged, open the furnace and throw in a handful of waste and the green smoke will ignite. With coke or anthracite, this is not so important, but with soft coals, some of which are 40 percent volatile matter, it simply means that 40 percent is wasted unless 3 or 4 feet of the furnace is arched with white hot brick and some air fed in through the star drafts in furnace doors. The heating surface lost will be more than made up by the increased temperature of the fire and increase of economy.

Coke, lamp black and charcoal are almost pure carbon, with a little tar and foreign matter, and run about 14,500 British thermal units per pound. A British thermal unit is the amount of heat necessary to raise the temperature of 1 pound of water 1 degree F. in temperature.

Anthracite coal ranks almost the same in value, although its structure is different, and it is more compact than any of the above.

All other coals have less and less carbon and more hydrocarbons. The hydrocarbons are mostly liquids and gases known as tar, vapors or plain illuminating gas. As the coals become softer these increase until in the peats and lignites we have 80 percent or more. Finally comes asphalt, paraffine, petroleum and gas, which has no free carbon at all and is all hydrocarbons or pure hydrogen.

Hydrogen has a calorific value of 62,000 British thermal units, hence it is easy to see that the more hydrogen a fuel has the hotter it is. Thus oil is hotter than coal; but physical conditions modify this, because it is difficult to burn soft coals properly, even though they have more heat in them. They must first be coked, which, with some coals, leaves only 30 percent of original weight. All of these volatile constituents must either be burned or wasted. They will only condense under a boiler, but burn finely under white hot brick. It is a problem any good, practical man can work out if he only understands the conditions. This is the source of the mysteries of air over the fire, air behind the bridge wall, etc. The practical man must remember that ignition must go with air, and he should see flame wherever air is introduced, or he is doing harm instead of good. Ignition is only obtained from a fuel bed, or white hot brick. It is an old saying that smoke once formed cannot be burned. It positively can be and is burned in any of our smoke ordinance cities by passing it through a white hot chamber with air. The whole system of having a fire under a relatively cool boiler is, in the opinion of the writer, a mistake. Those engineers who have experimented with a Dutch oven, in which the fire is surrounded on all sides by white hot brick, have been amazed at the results. The gases then pass through the boiler in the usual way, little smoke is produced, and the flames have a full sweep.

It takes, roughly, 16 pounds of air to burn 1 pound of fuel of any kind. It is possible to actually operate a well-managed furnace very close to this. Most firemen use too much air. Now it costs just as much to heat air and shoot it out of the smoke stack as to heat water in the boiler. Without going into the technical part, it is enough to say that if twice enough air is used the loss is about 10 percent; if three times, 20 percent, etc. It is not infrequent to find marine furnaces running ten or twelve times too much air, and using double the proper amount of coal. Many engineers think that when the stacks burn clean the fire is fine. No greater mistake could be made, as when the stack tops are clear there is all probability of excess air. The most economical firing is with the stacks just showing a little smoke, which shows that there is just a little less air than enough, which is much better than too much. Most engineers know that a valve is wide open when open one-fourth its diameter. The same applies to an ashpit door; yet one usually sees them wide open. They should be closed until the stack just begins to smoke. It is not necessary to use the dampers, except for protection of the boilers, as the ashpit doors always furnish enough regulation.

It is always easy to have a chemist analyze the stack gases, but the analysis means little to the average engineer, although it is very simple, as follows: Again skipping the technical explanation, an excellent combustion under practical conditions, with very little excess air, shows about 14 percent carbon dioxide and 80 percent nitrogen, and other things not important to the engineer. Now if the nitrogen goes up, the dioxide will go down, which means too much air. If the nitrogen goes down, the dioxide cannot exceed about 14 percent, but monoxide will be present, which means too little air. Suppose your chemist reports as follows, after you have taken a sample of chimney gases and given them to him:

CO_2	13.8 percent
CO	2.5 percent
O	2.5 percent
N	81.6 percent

This is a very typical analysis. The 2.5 percent of monoxide indicates that the combustion is incomplete in some part of the furnace, and the 2.5 percent of oxygen indicates that there is an excess of air in another part of the furnace; also illustrating that it is not possible to produce theoretical results. The 13.8 percent of dioxide indicates, on the whole, excellent combustion. Always remembering that the dioxide cannot go much above 14 percent, since there is only that much oxygen in the atmosphere. Now here is another analysis, taken from a forced draft, with much black smoke.

CO_2	3.4 percent
CO	
O	16.8 percent
N	76.8 percent

The low dioxide and high oxygen show that the furnace has nearly four times too much air. If it is necessary to force the fire at this rate it should be carried much heavier; still, forced draft always exaggerates spotting of the fire, air holes, etc., and excess air at one point may be adjacent to a monoxide bed at another. The ideal conditions for forced draft are in an incandescent Dutch oven, with plenty of room for excess air and vapors or gases to mix and burn between white hot brick and fuel bed before passing to the boiler. It will be noticed that the percentages in the last test do not add up to 100 percent. It will also be recollected that the stack was smoking badly. In taking samples, the free carbon known as smoke settles in the tank and is not measured, but the difference, about 4 percent, is probably free carbon, constituting another loss in forced draft, which would all be consumed by the enormous excess of air if a hot mixing chamber were provided.

Some well-known tests run about as follows, and are put in here for reference:

CO_2	CO	O	N	
13.8	2.5	2.5	81.6	....no smoke visible.
11.5		6.0	82.5	....old fire, white smoke, forced draft.
8.5		8.0	83.0	....fresh fire, black smoke.
2.3		17.2	80.5	....old fire, damper closed.
5.7		14.7	79.6	....old fire, white smoke, forced draft.
8.4	1.2	8.4	82.0	....new fire, natural draft.
12.0	1.0	4.4	82.6	....black smoke, natural draft.
3.4		16.8	76.8	....black smoke, forced draft.
6.0		13.5	81.5	....white smoke, forced draft.

Now, having reviewed the principles of combustion, let us look more closely into the sources of loss.

The greatest one, so far as pure firing is concerned, is the heating of the extra air, and it is of little use to install feedwater heaters and condensers with a wasteful fire to start out with. Assume a Scotch or watertube boiler, in which there is little brick work, and let us see what can be done. First, the ashpit doors can be closed until the stack just shows color. Then every leak beyond the ignition line, which means beyond the grate bars, must be stopped up.

The next greatest one is the unignited volatile vapors and gases. They are, first, the hydrocarbons, tar, essences, oils and gases, in the form of green smoke, principally; second, the monoxide formed more or less in every fire, and much in a deep fire; third, the free carbon given off as black smoke. The theory of the bridge wall, whose marvelous qualities are regarded almost with the superstition of ignorance by some, is that it will be heated to incandescence and ignite these gases passing over it; but it seldom does, and its usual value is merely a wall between the ashpit and combustion chamber, which seldom does the "combusting" that is expected of it. The writer has in several instances (none of them on shipboard) checkered that bridge wall clear to the top of the furnace, so that all products of combustion passed through it, and then either admitted air over the fire or saw that the fuel bed had some excess. In every case the bridge checker would get white hot, and from every checker opening would stream a long flame out into the combustion chamber. The best results from this were obtained by firing in front and shoving it to the rear. All the clinker would gather in the back, and could be hauled out from time to time over the fire with no great trouble, and the fires never had to be cleaned in the regular way. Shoving the fire back was done with a hoe, and only about three inches of depth was shoved at a time.

Industrial furnaces for smelting, glass making, steel making and gas making could well be studied by the mechanical engineer. They all require high temperature. While the designs vary, the principles are as follows: The fire, no matter what the fuel, is surrounded by white hot brick. The waste heat, or stack, leads through checker brick, which it heats up to a red or white heat; then the draft is reversed, and the incoming air leads through this brick, or "stove," as it is called, and heated to igniting point before reaching the fire, and the waste gases meanwhile are passing through another stove, the point being that the fires are kept hot and economical and combustion is complete, there being no cold points, like a boiler, for combustion to impinge on and cease.

Another smaller source of loss is radiation. The radiation from steam surfaces is pretty well understood by the average conscientious engineer; but how often has this excellent fellow thought of the radiation from his furnace fronts that goes up the ventilator? When the fires are out a fire room is not very hot, even if all the boilers are under full steam; but when the fires are all going, it takes the best of ventilation to make things bearable for firemen. Again skipping technical figures, it may be stated that four 36-inch ventilators under average draft will force down enough air, which, when heated to 150 degrees F. (the average temperature of fire-room ceiling), will take several tons of coal per day. Now, only a small part of this goes to the grate bars; the rest can be found by any practical engineer who will go stand on his stack gratings or engine-room hatch when under way. The remedy is to lag furnace fronts, or baffle them; same with back connections and side walls of watertube boilers. Stacks do not matter, unless containing a superheater, as the heat is past being made use of.

There is no possible way of adding steam to a fire so as to make the fire hotter. It is a fine way of holding fires, on sudden call, by forcing it in over the fire. If put in under the fire, in the ashpit, it cools the fire next to grates, forming monoxide and hydrogen, which burn at the top of the fire. It keeps the grates cool and reduces clinkering, but in forming the monoxide and hydrogen it absorbs exactly the same amount of heat that it gives off when burning later, and no possible gain in economy is to be accomplished; but with heavy fires and forced draft is a great saver of grate bars.

In connection with monoxide, it should be noted that when the fire room is closed, as in a torpedo boat, and the blower stopped, or very slow, right after a heavy run, it is possible for large quantities of monoxide to form and fill the fire room, also hydrogen. Hydrogen merely suffocates, and the prescribed treatment for drowning will quickly revive; but monoxide poisons by carbonizing the blood; the recovery is slow and uncertain if patient is unconscious. The only remedy is pure oxygen, administered immediately. The next best, but forlorn hope, is pure air and such means of heart stimulation as may be available.

A great deal may be learned by proper attention to symptoms externally manifested. A stack should not run more than 400 or 500 degrees in temperature. This may be ascertained roughly with a piece of sulphur. If it melts instantly and freely, when pressed against the stack, it is above 500 degrees; if it melts slowly, or not at all, the stack is reasonably cool. A flue or firetube boiler with large grates and comparatively small heating surface will run with a very hot stack, in spit of anything that is done; while a watertube boiler or other type with plenty of heating surface will run nicely at 400 or 500 degrees. Forced draft, of course, raises the stack temperature very high. Short circuits, due to broken baffles, or baffles left out, cause stack to heat. Excess air has a very pronounced effect on stack temperature, and can be easily noticed. Dirty tubes, scale or other matter preventing heat from passing freely to water will heat stack. Steam under grate bars will heat stack, and over grate bars will cool stack.

There are three types of fire that are decidedly wasteful: First, a bright, clean fire, with no smoke, dampers and ashpit doors wide open and boiler steaming light; second, a smoky fire of any kind anywhere; third, a deep, heavy fire, all incandescent, but dull red on top, with light draft, no smoke and no surface air.

The correct way to fire is to open dampers wide when load is fairly on and close ashpit doors. If there is no smoke and steam keeps up there is enough air leaking in for necessary purposes. If smoke shows, the doors may be opened until it almost disappears, but no more. A little smoke insures that there is not too much air. A good, clear flame insures that there is enough. The smoke right after firing cannot be prevented except with white hot arches and air over the fire.

Jet black smoke is pure carbon escaping unburnt. Green smoke consists of hydrocarbons, tars, vapors and gases escaping in the same way, and is a larger loss than the black smoke. Blue smoke is wood, waste, lubricating oil, etc. White smoke either contains lots of steam, or is the result of oil being thrown into a furnace without burning. Red smoke is the result of forced draft, and is really flame.

No gas can be seen, and their presence can only be detected chemically. Vapors from coal can be seen as green smoke, etc., but many vapors are invisible.

The chemical equivalents of the substances in fuels run as follows: Carbon, 12; hydrogen, 1; oxygen, 16; nitrogen, 14; sulphur, 32.

The substances of which fuel is composed are very complicated and cannot be gone into; but they are not important, because the engineer merely finds out from his chemist or somebody else's chemist the total hydrogen, carbon and other components, irrespective of their form of combination, and the engineer, knowing that they burn to dioxide and water, can calculate the calorific value of his fuel.

Hydrogen gas requires 8 pounds of oxygen for 1 pound of itself to form water, or 36 pounds of air (which contains the 8 pounds of oxygen), and gives off 62,039 British thermal units in doing it.

Carbon requires 2.7 pounds of oxygen, or 12 pounds of air, and gives off 14,500 British thermal units, burning to dioxide; but if it burns only to monoxide it gives off only 4,400 British thermal units. Sulphur gives off 4,000 British thermal units. Hydrogen burns with a bright silver flame, monoxide with a pale blue flame, and is usually seen burning on top of a quiet bed of incandescent fuel. Hydrocarbons of all kinds burn with heavy yellow flames, unless there is an excess of air, when they burn with blue flame. Pure carbon or coke has no flame and burns by incandescence alone. Sulphur burns with a blue flame of pungent odor.

A Bunsen burner is an illustration of an over-supply of air. While the inner tip, of silver color, due to hydrogen, burns at a fairly high temperature, the products of combustion pass off at a low temperfature, and it is an uneconomical although very practical method of heating; it is burning much more efficiently when the flame is yellow but not smoking, and the products of combustion are hotter, although the local temperature of combustion is less. A gasoline torch is another illustration. The theoretical temperature of combustion is the heat to which the theoretical products of combustion are raised by the heat given off. It is calculated by dividing the total heat by the specific heat of the products of combustion. Actual results fall somewhat short of this because of dilution and radiation, but regenerating furnaces frequently exceed the temperature of combustion, because the air and fuel are so highly heated to start with. Oxy-acetylene flames and thermite processes attain much higher temperatures, but these are manufactured fuels that represent the artificial storage of immense amounts of energy, comparing in value with explosives rather than cheaper fuels. Extremely high temperatures have few useful applications, even were they easily available; and we will do well to faithfully develop the art of large, medium temperature fires on an economical basis. Any good apprentice boy can, under proper supervision, overhaul an engine. An average engineer can run a very large engine, given the opportunity; but the boiler, which combines more science, loss, opportunity, danger, energy, complication, and thought than all the rest of the plant is put in charge of men of exceptional ignorance.

The most successful engineer the writer knows, chief of a 40,000 horsepower electric plant, has, for several years had his "youngsters," as he calls the younger assistants, take complete charge of the engine room. Himself personally and right-hand men watch the boiler room. The engineer on watch has his desk there, and goes only occasionally into the engine room, and a boy tends the "throttle." The boiler room looks like "my lady's parlor." The top of every stack is visible, the ashpit doors are controlled from one point, as are also the dampers. The firemen know their business and receive more than the engineers. They do not do the shoveling, but oversee it. They are the first, second and third engineers, and some of them started in as shovelers, went to the engine room, and came back. They receive lessons in combustion, fuels, heat, etc. They have obtained results that, probably, have not been exceeded in this country; and this without patent grates, feed chutes or any other modern improvement, unless it be the greatest of all, common sense and brains in the fire room.

A REASONABLY TRUE STORY, AS TOLD BY A TWO-FLUE BOILER.*

BY CHARLES S. BLAKE.

Some years ago I had the misfortune of being born, but since I came into the steam world I have conscientiously endeavored to conduct myself in a manner becoming my station in life. I cannot tell where my parts came from, but they were doubtless from some good place, because the materials were faultless. My makeup was of the ordinary kind, but I claim a lineage dating far beyond some of the new kind of so-called boilers. I am now about ten years old. I suppose this would be called middle-aged, though I am prematurely worn out. I was purchased by a mine owner, who gave me a permanent home in the coal regions of the Hocking Valley, where I was surrounded by other helpmates. We were placed side by side, so that we could work in harmony, and we enjoyed the same pleasures and suffered the same sorrows.

We were given water to drink, and at most times we had all we wanted. This, too, was a good feature of our care for our thirst seemed unquenchable when we were warm, and the greater the temperature the greater the thirst became. It is upon this subject of drinking water that I shall say the most, for the quality served to us was, in the end, the cause of my downfall. It was mine water that they gave us. It was collected in a reservoir, and during what you would call a dry season it became quite roily and tasted bad. At times it was quite fishy. However, we managed to get along all right by having our insides washed out once in a while. We naturally grew a little crusty, and we had some sore spots. None of these seemed to threaten our lives, however, until for some inscrutable reason we were given water to drink that not only nauseated us, but also fairly burned our vital organs. We manifested our discomfort to our master by emitting blood from our joints. A day or so later we had another change, but, while the new water tasted somewhat different, it acted in the same way upon our constitutions.

After one month I realized that I was going into a rapid decline. I tried to bear up under the thought, but one day a lung was punctured and I had to go out of commission until my master inserted a bolt in the opening. This served to stop the flow of blood, and I was again "fired up." I was very weak, but rallied and tried to do my duty. A few days later one of my companions collapsed and died. I was so grieved and indignant that on the spur of the moment I, too, rebelled, collapsed, and—horror of horrors!—killed my master. I have been very repentant ever since, but that will not bring him back again. I knew he liked me, though he had a knowledge of my feeble condition when he plugged my lung.

I might say, right here, that I am able to translate this story by the aid of an expert who makes a specialty of investi-

* From "The Locomotive."

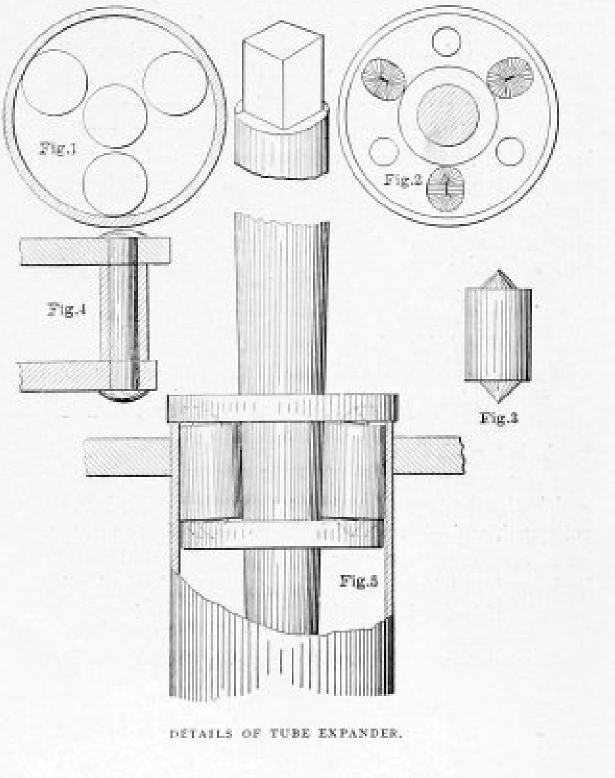
gating the causes of troubles, such as my own, and holding autopsies. He was sympathetic and understood boiler talk, so I confided to him, and he, in turn, helped me translate my experiences. He explained that the water that had brought me to an untimely end was strongly impregnated with sulphur, which must have come from the mines. That is what had eaten my vitals away so rapidly. What is to become of me now I do not know. My boiler friend thinks I ought to be cut up and worked over into some other product, where the dangers are not so great. I should not object to this; but if they sell me to a second-hand dealer, and he tries to repair my organs, puts a coat of paint on me, and then sells me for a boiler "as good as new," I shall most likely make a further record as a man-killer.

EMERGENCY TUBE EXPANDERS.

BY EL'GOMO.

The tube expander is certainly a valuable asset in the boiler trade, and considering the many types and makes of this tool there is no excuse for the craft to lack anything in this equipment, but no doubt there are a number of readers of THE BOILER MAKER who recall incidents where the expander gave untold trouble, particularly when many miles away from the shop. With an old expander, and one that was in poor condition at that, in some cases the rolls would fall out, or the tube holes were large, the tubes worn, and the expander would not expand, a defect which was frequently found with the early makes of expanders. And how about the boiler owner who quite likely wanted that boiler at once, and no doubt was expected to sign your time card for double time? Did you not brush up some plausible excuse, and resolve how you would get even with the boss when you returned to the shop?

There are many shops in which only modern, up-to-date expanders are allowed or kept in service, but there are others where no such restriction is made. Then there are cases where sudden calls are made for work, including repairs where expanders of unusual types or sizes are required, possibly at some remote place where it is a question of unreasonable distance and time to obtain the proper tools. It is just such conditions that prompted the writer to prepare this article, and it is backed up with practical experience. It is possible to make a tube expander, such as shown by photograph and sketches, at a small cost and with few tools; in fact, it can be made at the blacksmith's forge if there are no other available tools or means at hand.



DETAILS OF TUBE EXPANDER.

The photograph shows a 3-inch tube expander assembled, and the rolls for same, also extra plates for a larger size. These expanders have been made in sizes from 2½ inches up. Three rolls were used in the 2½ and 3-inch, and four rolls in the larger sizes. The material required for the discs or end plates can be made from any flat stock found, such as bunker, deck or tank plate. The rolls and mandrel can be made from tool or other rather high-carbon steel.

Fig. 1 shows the layout and proportion for a 3-inch expander. The internal diameter of the tube is divided by 3 for the roll diameter, and the small end of the mandrel should be about 3/16 inch smaller. In the case at hand the roll diameter is ⅞ inch.

Fig. 2 shows the layout of the end plates. In order to sink the oval pockets an elongated tool is required, and this is suitable for all size rolls. These plates can be made from ¼ to ½ inch thick.

Fig. 3 shows a roll for a 3-inch expander, and Fig. 4 shows one method of securing the plates in position to retain the rolls. Either a rivet or bolt with a socket or a threaded stay without a socket is practical. In Fig. 5 the complete 3-inch expander is shown in working position.

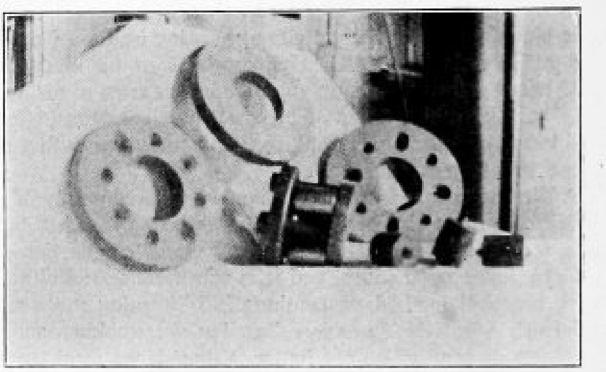


FIG. 6.—THREE-INCH EXPANDER.

The mandrels vary in length and taper as occasion requires. Fig. 2 shows the small end of the 3-inch expander. This type of expander will invariably clinch or flare the tube end, regardless of wear, owing to the end plate remaining close to the roll.

In case the expander is required for inside work, such as watertubes or pipe joints, a duplicate plate, such as shown at bottom of Fig. 5, is required in place of the top plate, also means for holding the expander at the proper position.

No doubt the craft will recall instances where the tubes were rough inside and it was difficult to manipulate certain types of expanders and obtain good results. This expander has been tested out in just such cases and has made good, which is attributed to its flexible design, and it is free from undue friction, which is unavoidable with certain types of expanders.

In conclusion, the writer will state that those who find it difficult, by reason of their condition and location, to obtain the standard types of expander found in the market, should find the expander explained in this article not difficult to make, and no doubt it will prove of value in many cases. Should the readers desire any further information as to the details of making the expander, just make it known through the columns of THE BOILER MAKER.

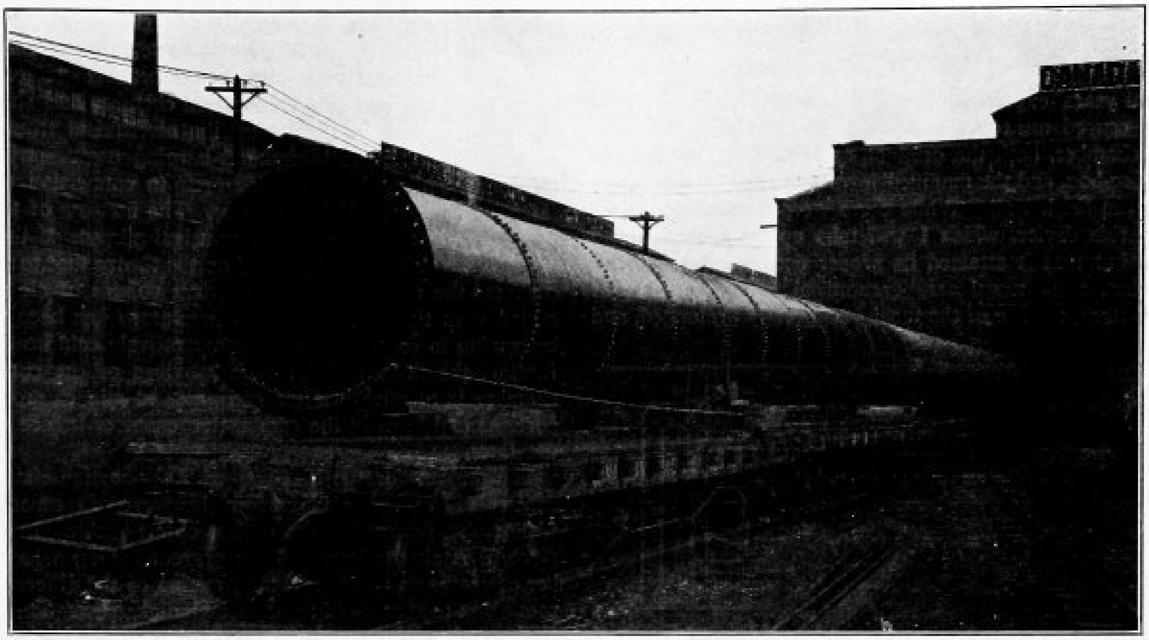


FIG. 1.—INTAKE PIPE 72 INCHES DIAMETER BY 168 FEET LONG BUILT IN A CANADIAN BOILER SHOP.

Product of a Canadian Boiler Shop.

Figs. 1 and 2 show some work which is being done at the Canada Foundry Company, Toronto, Ontario, Can. The pipe shown in Fig. 1 is 72 inches diameter, 168 feet long. This was built for the city of Toronto water works, to be used as an intake pipe. Three lengths of this pipe were built, each weighing 45 tons; two tees and two flexible joints were also a part of this job.

Fig. 2 shows six gas producers for the Dominion Iron & Steel Company. There is also being constructed for the same company four stoves, 21 feet diameter by 85 feet high, and two of the largest blast furnaces in America and some 500-ton open-hearth furnaces. All this work, of course, involves a large amount of piping. Besides the particular work mentioned the Canada Foundry Company does all kinds of plate work; builds watertube boilers, locomotive and return tubular boilers, steel boiler fronts and all kinds of oil tanks, steam shovels, etc.

J. E. WEISE.

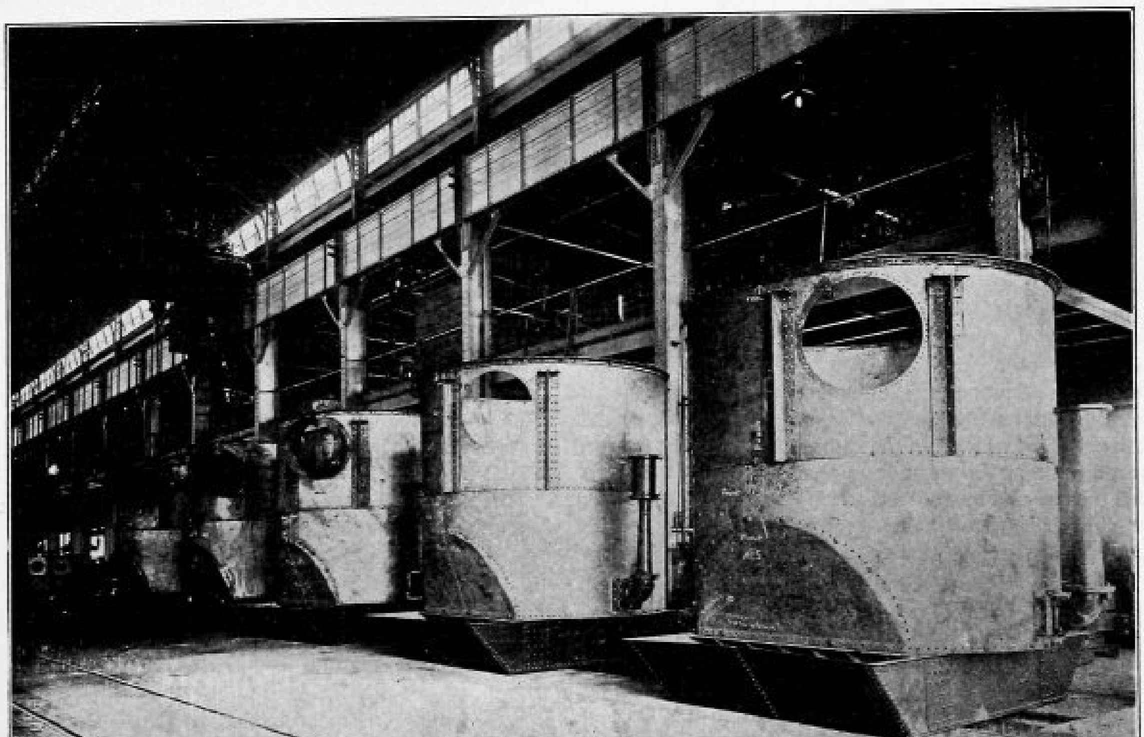


FIG. 2.—GAS PRODUCERS BUILT IN A CANADIAN BOILER SHOP.

IMPROVED FIRE-BOX WITH HOLLOW ARCH AND COMBUSTION CHAMBER.

BY F. F. GAINES.*

Several years' experience in the anthracite district of Pennsylvania caused me to become quite familiar with the combustion chamber, both the original, as applied to the Wooten type of fire-box, and the modified form as used to some extent without the brick wall. While there were mechanical objections to this device, which I will take up later, there is no question but that it attained its proper end and did improve combustion, and proved very economical in the burning of fuel. Further, the life of the tubes was greatly prolonged, and in no case during the life of the tubes was there nearly as much trouble given as in the ordinary type of engine. I have also found, from two engines of the same class identically the same in every respect, except one with the combustion chamber and the other without, that the engine with the combustion chamber, although having less total heating surface, due to the flue-heating surface cut out by the combustion chamber, was in every respect the better steamer of the two. This would be somewhat borne out by the fact that while the combustion chamber engine has less total feet of heating surface on account of less flue-heating surface, yet the additional fire-box heating surface in the combustion chamber is of so much more value as to offset the loss in the flue-heating surface.

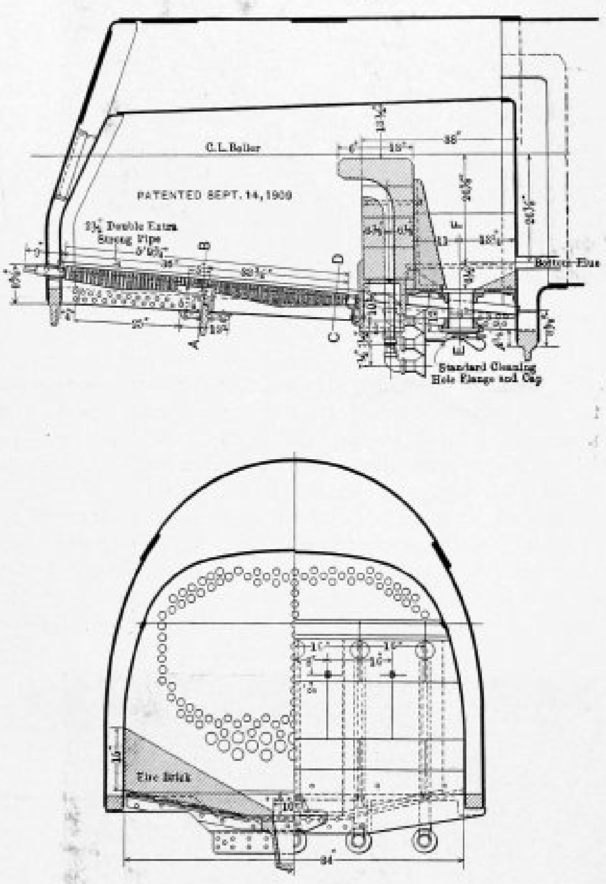


FIG. 1.

The Wooten type of boiler has been for years standard on the Philadelphia & Reading Railway, and very justifiably so from the results obtained. Other roads have used it somewhat in a more or less modified form, and within the last few years several roads have been applying it to engines using bituminous coal as a fuel. As far as I have been able to ascertain the results have been uniformly successful. It would seem that in such types of engines as require extremely long length of flues, that very much better heating surface can be obtained by the use of a combustion chamber and shortening the flues, as well as decreasing the mechanical troubles due to long flues. Some bituminous-burning engines with combustion chambers have a brick arch in connection with the same, while others are using none. The non-use of the brick wall seems to me to defeat the principal purpose of the chamber itself, which is largely based on the theory that to properly consume the unburned gases sufficient volume of air must be mixed with them before their temperature has been lowered by coming in contact with the comparatively cold heating surface of the flues, and that the province of the combustion chamber is to allow the air and gases to mix in proper proportions and burn in the combustion chamber before entering the flues.

The present form of fire-box with combustion chamber, as constructed generally heretofore, has several mechanical defects which render it more or less objectionable. In the first place, it is almost impossible to prevent having a large number of seams on account of the junction of the different plates coming at the throat of the combustion chamber. This is even true where a single plate is used for both fire-box and combustion chamber by welding the two sheets together, as the throat sheet seams are still located at this point. Where the brick arch is used it is necessary, about once a week, to draw the fire and allow the arch to cool, put a man behind the arch to shovel out the accumulation of cinders to prevent stopping up the flues. This, of course, requires considerable time, and withdraws the engine from service while the work is being done. There is also an objection on account of the trouble experienced with cracked sheets, unless the mud is kept from accumulating in the water space underneath. Where water that is high in solid matter, either mud or scale, is used, this matter must be looked after very carefully.

Knowing the desirable features of the combustion chamber as regards saving of fuel, diminution of smoke, longer life of flues and better steaming engine, I made a very careful study of the whole matter to see what could be done to get the advantages of the design in question and eliminate the objections. With this end in view I finally evolved the idea of building a boiler with an abnormally long fire-box, and partitioning off sufficient space at the front end, by a vertical brick wall, to form a combustion chamber, thus allowing me to put an ordinary spark hopper in the bottom of same for the withdrawal of sparks. I further believed that the admission of heated air at a point near the top of the bridge would be of advantage in approximating complete combustion. To accomplish this the brick wall in question was made hollow, with passages through it so that air might enter from the outside, go through the wall itself; which, being hot from the high temperature of the fire-box, would also heat the air and turn it loose to mix with the gases at top of bridge, the idea being that they would mix and burn during their passage from that point to the flues.

This design eliminates the trouble of removing sparks which gather in the combustion chamber and stopping up of flues. It also admits highly heated air at the most desirable point for complete combustion. It also protects the flues from any cold air, no matter at what point in the fire there happens to be a hole.

To carry out the idea in question, the management of the Central of Georgia Railway allowed me to apply a new back end, embodying these principles, to the boiler of one of our large consolidation engines (No. 1,014), which had been in an accident and had badly damaged the back end. This fire-box is shown in Fig. 1.

* Superintendent of motive power, Central of Georgit Railway Company.

The grate area of the new fire-box in question was made identically the same as that of our 22 by 30-inch class consolidations, which are free steamers and economical as regards fuel. The combustion chamber was made shorter than would have been used if the boiler had been designed in toto for the engine. It was necessary, however, to design a back end that would go on the old boiler and suit the running gear of the present engine, which somewhat modified the design from what would have been considered best practice. Nevertheless, this engine has now been in service some fifteen months, and so far we have yet to have the first trouble from leaking flues, although the engine is running in a district where other engines are giving us trouble more or less all of the time, and where the average life of a set of flues is about 30,000 miles.

It has been found that this engine will steam with grades

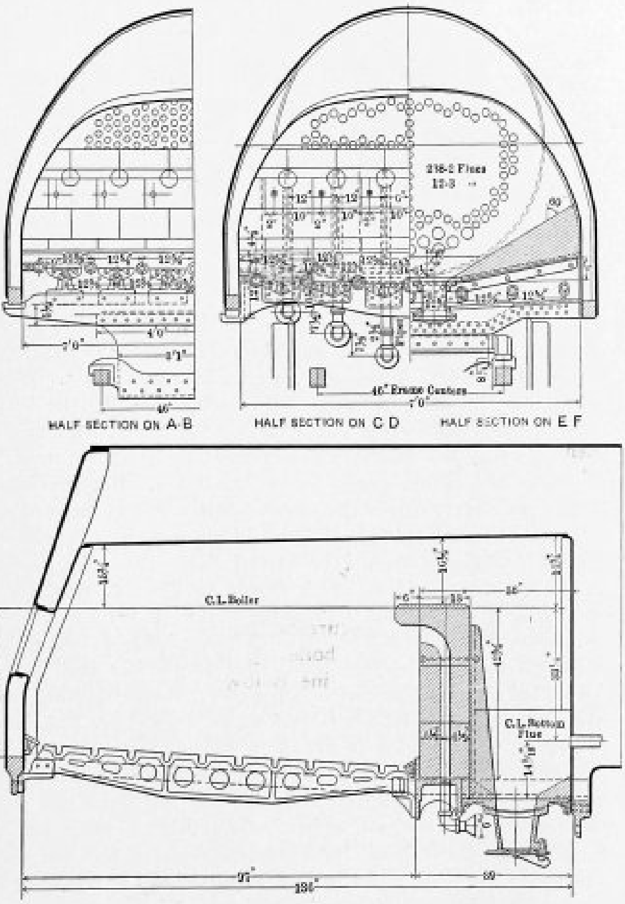


FIG. 2.

of fuel that other engines cannot use, and this arrangement appears to be of advantage in utilizing low-grade fuels, and would probably prove very satisfactory in burning lignite.

This engine so far has made 37,832 miles, and apparently the flues are in as good condition as the day they were applied. The engine will soon be due for general overhauling, but it is not the intention at that time to do any work whatever on the flues.

It has also been found that whatever small amount of sparks accumulate in the combustion chamber can readily be removed through the spark hopper at the bottom, but as a matter of fact the amount of sparks carried over the bridge wall is very small. This is probably due, in the first place, to the use of a large nozzle (6½ inches), and the modified mild exhaust not lifting anything but the smallest particles over the bridge. As these small particles are lifted over the bridge, such as are combustible are probably burned before they strike the flues, and the only sparks that are found in the combustion chamber or front end are very fine particles of slate, and very few of these.

It has also been noticed by all who have ridden this engine when working, that the amount of smoke emitted is noticeably less than on the other engines. The fuel consumption has been considerably less, and the engine in every way has proven extremely satisfactory.

The management has also allowed me to apply this revised back end to the boiler of another type of engine of smaller size (No. 1,065), the fire-box of which had been badly damaged by low water. On this latter engine I decided to carry out further previous experience I had had in regard to circulation of water in Wooten type fire-boxes with longitudinal grate with a water-bar between each grate. This was embodied in the second engine, in connection with the hollow brick arch and combustion chamber, as illustrated in Fig. 2, showing the combustion chamber and grate arrangement.

This engine has now been in service, since being rebuilt, about four months, and while no official tests have been made as to fuel economy, the road foreman of engines and engineers report that it is one of the most satisfactory engines on the division, and there is every reason to believe that the fuel economy is going to show up as well as on the first engine.

A record of test of the first engine equipped is given herewith. In this test the train was composed entirely of cars of company coal of 100,000 pounds capacity, and the same train was used throughout the whole series of tests, thus eliminating any error from difference in class of work or weights used during the test. Three grades of coal were used, and they are designated as "A," "B" and "C," from three different mines, and the average of all is summarized. Engine 1,014 is the

ENGINE TEST—FREIGHT SERVICE.

Same Eighteen Carloads of Coal Hauled in Each Test. Same Engineer and Fireman Each Test.

Engine No.	Pounds Coal Consumed per 1,000 Ton Miles.	Pounds Water Evaporated per Pound of Coal.	Relative Efficiency.	Per cent. of Excess Coal Consumed Based on Engine 1014 as Unit.
COAL, No. 1.				
*1014	102	8.10	100.00	......
†1020	152	5.70	67.11	49.02
‡1719 (1)	108	8.57	94.45	5.88
§1715	119	7.72	85.72	16.67
COAL, No. 2.				
*1014	100	8.12	100.00	......
†1020	141	5.65	70.93	41.00
‡1719 (1)	....	......	......	......
§1715	114	7.44	87.72	14.00
COAL, No. 3.				
*1014	96	8.25	100.00	......
†1020	139	5.93	71.95	44.79
‡1719 (1)	....	......	......	......
§1715	110	7.66	90.92	14.58
GENERAL AVERAGE OF ALL COALS.				
*1014	99	8.15	100.00	......
†1020	144	5.76	68.76	45.46
‡1719 (1)	108	8.57	91.67	9.09
§1715	114	7.61	86.84	15.15

* Engine 1014.—21 x 32" Cooke Consolidation with new firebox and combustion chamber, with hollow brick wall and provision for mixing hot air with burning gases. Total heating surface, 2987.33 square feet.

† Engine 1020.—Same class engine as 1014, but with original boiler unchanged and no brick arch. Total heating surface, 3022.29 square feet.

‡ Engine 1719.—22 x 30" Baldwin Consolidation, with firebox and Wade-Nicholson hollow arch. Total heating surface, 3230 square feet.

§ Engine 1715.— Same as engine 1719, but without brick arch. Total heating surface, 3230 square feet.

(1) Engine 1719.—out on test of Coal No. 2 and Coal No. 3 account of arch burned out and no material on hand to repair.

engine with the combustion chamber; engine 1,020 is a sister engine of the same class, but with the original boiler not equipped with a brick arch; engine 1,719 is an engine of better design, wide fire-box, with Wade-Nicholson hollow brick arch; engine 1,715 is the same class as the 1,719, but without the arch. We had to eliminate engine 1,719 from the tests with the last two grades of coal, due to the fact that the arch gave out, and we did not have material on hand to make repairs. The showing, however, over the other engines made by the 1,014 was very satisfactory and substantial. In making the tests all coal used was weighed and put up in sacks. The data sheets show the principal dimensions of both engines.

FLUE FAILURES.*

Flue failures start, in a great many cases, in the designing room, by crowding in too many flues, placing them too close to the heel of the flange, or with too small a bridge. Even when properly designed the layer-out often uses his own judgment and places the flue wrong. After the flue sheet is laid out the driller plays his part by drilling the holes too large. The cause, in some cases, is that the cutters are not ground right, or that there is too much lost motion in the spindle of the drill press. It is important to have the holes drilled the exact size and uniform, as it is impossible to keep flues tight in large holes. All holes should be chamfered on both sides. The copper furrules should be expanded by a sectional expander, and never with a roller, as the roller reduces the gage.

An Atlantic type engine came into the shop for a new fire-box, and when removed I found the flue sheet had moved upward in the center about 1⅜ inches, making the crown sheet look as if it was dropping down; when a straight edge was placed on it we found that the crown sheet had started to rise about 18 inches from the back flue sheet. I put a straight edge on the new fire-box and found it straight; then I got a tram and trammed it in the center of the flange on the top and the lower point between staybolts. The flues were set by expanding with sectional expanders and rolled very light, then beaded with a standard beading tool and inspected before the flue setter left the job, to insure proper work. I then trammed the sheet and found that it had moved upwards 3/16 inch. I sent the tram with the engine for future tests and had the men report the movement of the sheet every time the flues were expanded. It was as follows:

On Feb. 4, 1910, flues expanded and trammed after work was completed; found a movement of 1/16 inch, or a total movement of ¼ inch upward.

March 11, 1910, expanded light, still ¼ inch.

April 15, 1910, expanded light, still ¼ inch.

May 29, 1910, expanded light, moved 1/32 inch; total, 9/32 inch.

July 10, 1910, expanded light, moved 1/32 inch; total, 5/16 inch.

July 20, 1910, expanded light, full set moved 3/64 inch; total, 23/64 inch.

Aug. 18, 1910, expanded light, full set moved 1/32 inch; total, 25/64 inch.

Sept. 20, 1910, expanded light, full set moved 3/64 inch; total, 7/16 inch.

Oct. 8, 1910, expanded light, no movement; total, 7/16 inch.

My object in making this statement is to show what this movement does later. The boiler is tested, and if the material is all right, no flues have to be renewed, but on the other hand, if it is poor material, and the lap welds are not properly welded, we find the flue fails at this point in the expanding. I have, however, found cases in the center of the flues where they may fail at any time afterward in service.

The engine is ready for service, and shortly afterward it fails on account of the flues leaking. What is the cause? We know the flue layout is not exactly correct, but the holes are drilled uniform and of correct size, and copper and flues were properly set and tested under 25 percent excess working pressure. We cannot say it is bad water, even if the engine is running in a bad-water district, because it has not been out of the shop long enough to gather enough scale on the flues or flue sheet to do any harm; it has been washed out properly every three or four days. This failure is surely due to abuse—feed water not properly applied or not fired right are two of the principal causes. The flues are and must be set back properly to the sheet again, and the engine will make successful trips, if the engine crew is taken to task by the right party.

We must keep the engine clean and free from scale by removing all washout plugs, especially those in the front flue sheet, and washing between the flues, back to the back flue sheet. Be sure that the long nozzle is used in every hole, because if you let it go until the space between the flues is filled up solid you all know what happens—flue failure after flue failure and cracked bridges. These flue failures are all up to the round-houses, but as we are going to keep the engine clean I will try and show why it still fails on account of flue leaking.

The engine arrives at the terminal with only a fair fire, not very much steam, and a half glass of water, not leaking, and is therefore not reported. The hostler gets on the engine and finds these conditions; rushes it to the cinder pit; puts on the blower and gets the fire out quickly so as to get into the house before the steam is gone—the water is also going fast. When he reaches the table he starts the injector and fills the boiler until the injector breaks, and what has happened? Every flue has started to leak badly, which means the whole set must be expanded before the engine leaves the house. But possibly it is the only engine in and the round-house foreman has ordered it out, because he looked at it on arrival and knew it was not leaking. There is then a failure of flues, either by holding and doing a proper job, which should be done every time, or by taking a chance and telling the boiler maker to calk her up, or dry her up and let her go. The engine goes out on the main line and ties up everything, due to another flue failure. This kind of a failure can be stopped by compelling all engineers to leave their boilers full of water, a good fire and plenty of steam. The engine is towed to the nearest round-house, and the boiler maker is ordered to do the necessary work. He starts by using a mandrel, and pins out the flues and calks them with a beading tool, which is altogether too large and has no bearing on the bead, but cuts and grooves the flue sheet and spoils the bead. The engine is started out and fails again on account of flues leaking. This pinning of flues and the use of improper beading tools have caused a great many failures and every foreman boiler maker should watch this matter closely and stop it.

Everybody in charge is after the engine now, and the orders are to put it in first-class condition before leaving the round-house. The flues are again expanded, this time properly, and well beaded, and it does good work for a few days, when a new hostler forgets the water and puts it in the house with 1 inch of water in the glass.

About two hours later the fill-up man finds no water in the glass and connects the hose to a blow-off cock located near the throat sheet. As the engine is ordered out he fills it up quickly with cold water, fires up and pulls out of house with a heavy fire. The engineer cannot see the flues, and when the boiler maker makes an inspection they appear to be tight. At the depot the fireman calls the engineer's attention to the flues leaking, and there is another flue failure. I might say here; Do not allow fill-up men to connect up to blow-off cocks if the

* From a paper presented by J. W. Kelly, foreman boiler maker of the Chicago & Northwestern, before the Western Railway Club, November, 1910.

fill-up water is cold. Better still, have a standard fill-up valve on top of the shell or dome, and do all the filling through this valve, thus preventing flue failures. This also applies where the engines are waiting for orders or have been standing on the side track for some time. The crew gets careless, allowing the fire to burn down, resulting in no steam; they receive orders to go, and on goes the injector; and what happens? Flues all leaking and engine soon gives out, thus causing another flue failure.

A great many flue failures are caused by careless firemen allowing the fire to get too heavy and having 2 or 3 feet of clinkers next to the back flue sheet, which stops circulation, causing the flues to contract and leak. Another cause is where engines are tied up and stand outside in cold weather. The fires are allowed to burn down and are only kept alive at the door hole. The injector must be put on, the cold water goes down to the bottom flues, and we get the same results as stated above—flues leaking.

There are several other causes, such as running with the fire-door open, leaky steam pipes, poor firing, by having no fire for 10 to 20 inches from the back flue sheet, filling up hot boilers in round-houses with cold water; in every case the flues must be worked over, and this continuous work in every case gives more or less trouble until the sheet is removed from the fire-box.

We all know what happens when beads drop off. Flues are plugged, especially if the throat sheet is short and the flues are too low down. If it is possible to run an engine with the bottom flues plugged, and it still does good work and is light on coal, why not leave these flues out, so they will not be there to contract and leak? With this point in view I got permission to experiment with one engine. I plugged up about forty flues and put a stay rod in the center of the plugs. The engine went into service and did as well or a little better as to coal, and steamed fine. The flues were applied Nov. 6, 1907, and the engine was put in heavy freight service for test purposes. Flues gave very little trouble, and were removed when the engine received general repairs to machinery, but they were still in fair condition on April 7, 1910.

The point I want to make is this: Do not crowd in too many flues because you must have the required heating surface. Keep the top flues down from 4 inches to 4½ inches from the flange to the center of the flue hole. According to our standard layout many of the flues are left out, and the plate is stayed with stay rods where the flues are left out. These engines when received from the locomotive works had 342 flues and ⅝-inch bridge. They have, with the present layout, 280 flues, 13/16-inch bridge, and the flues are laid out with the taper of the sides of the flue sheet, which gives a wider bridge in the bottom, better circulation and a chance to let the sediment down. I recommend this whereever it can be applied.

We are applying this scheme to all engines of this class receiving new fire-boxes or new back flue sheets, and are getting good service. You all know there are a great many engineers who never have leaky flues or any kind of a flue failure, and the flues run for several months without being expanded. This is why some boilers and flues give such good service. Flue sheets do not move upward so fast and cause trouble, while, on the other hand, engines of the same class with other engineers always leak and have all kinds of failures doing practically the same work. While the flues and flue sheet must stand for these failures, nevertheless they are men failures.

We know from tests on the New York Central that the flues moved upward. I have proven that the back flue sheet moves upward when the flues are continually expanded. Now, with the power getting larger all the time, these large boilers must have more attention; we must depart from the old rut and try and grow larger with the boiler, because we cannot expect the same results with the same methods we had when the boilers had 150 flues and carried 135 to 150 pounds steam pressure. It is my opinion that we must go even farther than above suggested, and meet this situation by reinforcing the back flue sheet in some manner to help take care of these sudden contractions of flues and the upward movement of the back flue sheet and flues. But with the present conditions we must hold engines from service when the flues become thin and have poor beads and remove them before they make several failures. Do not try to get just one more trip and fail on a very important train.

The method of taking care of flues at terminals is narrowed down to the sectional expander and beading tool. If flues are leaking slightly, use a beading tool that fits the bead properly and calk well. If a set of flues are loose and leaking badly they should be properly expanded and calked. The roller expander should never be used, as it rapidly thins the flue and reduces its ultimate life. The mandrel or tapered pin should under no circumstances be used, as this tool shears off the bead in time and only dries up the flues temporarily, and they soon become leaky and will fail. The beading tools should be watched very closely and kept up to the standard gage, as flat tools soon destroy flues.

Brick arches are playing their part in helping to keep flues tight, and should, in my opinion, be placed in all large locomotive boilers, tight against the back flue sheet, with an opening in the corner to allow sparks to go down. Among the advantages of the brick arch are fuel economy and better combustion. It reduces the cutting action of sparks on the beads by keeping a large percentage in the fire-box and stops the small, light fuel from passing through and stopping up flues.

In conclusion, we must educate everybody who handles engines to the importance of keeping an even temperature in these large boilers, of applying feed water correctly, and of properly opening blowers, and of the evils due to cooling the engine down too quickly and washing with cold water. The boiler must be washed out properly and must not be allowed to fill up with mud, which produces cracked bridges. All flues should be bored out; brick arches should be applied in every engine before leaving the round-house, and, at last, but not least, we must have good flues and flue work.

LOW WATER TEST OF A JACOBS-SHUPERT FIRE-BOX.

Complete descriptions of the Jacobs-Shupert locomotive fire-box have been published in previous issues of The Boiler Maker, and as thirty of these fire-boxes are now in active service on the Atchison, Topeka & Santa Fe Railroad, details of construction and the principle upon which the box is built are well known to boiler makers. There is one claim which is made for this fire-box, however, which has never been satisfactorily proved—that is, that the construction of the fire-box is such as to offer greater security from the disastrous effects of low water than the usual type of fire-box.

This claim has been investigated recently by subjecting a typical fire-box of this type to a certain pressure and temperature while the level of the water in the boiler was lowered to such an extent that the top of the fire-box was left uncovered. This is a condition under which nine times out of ten the crown sheet of an ordinary locomotive fire-box will go down and frequently cause an explosion of the boiler.

In the test oil was used as fuel and water was supplied by a pump located and controlled, as was the oil storage under control, at a safe distance from the boiler, so that a possible explosion could do no harm to the investigators. Compressed air was piped to the blower, whereby the necessary draft was obtained. Three pop safety valves, registering at 225 pounds pressure, two steam gages and two water glasses, one of which showed the water level several inches below the top of the crown sheet, were fitted; a white line was drawn on the back head of the boiler, to show the position of the crown sheet, and a scale graduated in inches was placed alongside the lower water glass, the inches being numbered downward from the crown sheet line. These arrangements were so made that the investigators could read the gages and the scale for water level at a safe distance by means of field glasses. The temperature of the crown sheet was measured by a pyrometer.

The test was conducted by first raising steam with water at the normal level, and then when the gages were registering 225 pounds the blow-off cock was opened and the water drawn off to a point 4 inches below the crown sheet; then by continued evaporation the water was lowered 2 inches more. By this time the pop valves were continually blowing. The fire was kept going with the same force against the uncovered crown sheet for about ten minutes, when it was extinguished, and water at a temperature of about 60 degrees was pumped into the boiler.

Examination of the boiler immediately after the test showed no distortion of the plates, and no visible defects either outside or inside of the fire-box, although when the boiler was turned over, so that the sheets could be examined by daylight, the crown sheet had the appearance of burnt material. Experts claimed, however, that the boiler was fit to go back into service without any repairs, and that it was not seriously damaged in any way by the test.

When it is considered that the maximum temperature registered in the crown sheet during the test was 1,125 degrees, it is evident that this form of construction of fire-box offers vastly more resistance to destruction on account of low water than does the ordinary type of fire-box. It is quite probable that an ordinary fire-box under similar conditions would have collapsed, and possibly caused the boiler to explode.

The results of this test, together with the record of the other locomotives of this type which have been in use on the Atchison-Topeka & Santa Fe Railroad, and which have never required any repairs, has led the officials of the road to specify this type of fire-box for the sixty-six additional locomotives which they are now building.

LEGAL DECISIONS OF INTEREST TO BOILER MAKERS.

Damages for Delay in Delivery of Boilers.

A contract was entered into by an engineering works corporation for the construction and delivery of a steamship by a certain date, under penalty of $100 per day for the first ten days' delay and $200 per day for subsequent delay. It contracted with a steam boiler manufacturing company for two boilers for the vessel. Prior to this contract it notified the boiler company of its contract for the steamship and especially of the damages it had stipulated to pay for delay and that it would hold the boiler company liable for any damages its delay in furnishing the two boilers might cause. On account of delay in delivering the boilers and other delays in completing the steamship the engineering works had to pay to its owners $13,300, and it sued the boiler company for $6,000 on account of its delay. The boiler company was held liable to the engineering works company for the damages which it had caused by its delay. In estimating these it appeared that the boiler company's plant was at Duluth, where it built the boilers, and it agreed to deliver them at Detroit, but failed either to complete them or to deliver them within the time fixed. The engineering works claimed, as part of the damages, the expenses it paid for freight and marine insurance on the boilers in their incompleted state from Duluth to Detroit, for a place at a slip and for the delay of the ship which carried them, for laying up the new steamship after the boilers were placed in it in order to complete there and for their completion. It was held that the questions whether or not under the circumstances of the case the delay of the boiler company in completing and delivering the boilers was the proximate cause of these expenses, whether or not they were necessary and the question of their amount, were within the province of the jury and were rightly submitted to them.—*Northwestern Steam Boiler & Mfg. Co. vs. Great Lakes Engineering Works. Fed. Cir. Court.*

Damages for Injuries to a Boiler Maker—Independent Contractors.

A paper company operated a battery of steam boilers in connection with its mill, any one of which could be disconnected from the others without interfering with the remainder. Some of the boilers being defective, the company contracted with the Sinket-Davis Company, a firm engaged in the manufacture and repairs of boilers, for their repair. They sent a boiler maker, the plaintiff in this action, to replace the defective flues and make other necessary repairs. He reported to the paper company's chief engineer, who put him to work. While he was engaged in one of the boilers, the paper company's fireman negligently turned steam into the boiler, which scalded the plaintiff before he could escape. In an action by him against the paper company for damages it was held that he was entitled to recover. He was the servant of an independent contractor, and not of the paper company, and hence was not a fellow servant of the fireman. He was entitled to assume that reasonable care would be exercised for his protection, and hence the negligence of the fireman was the negligence of the paper company.—*United States Board & Paper Company vs. Landers, Indiana Appellate Court.*

Implied Warranty of Steam Heating Plant.

The owners of a building, consisting of storerooms, offices and flats, entered into a contract with a plumbing company for the installation of a steam heating plant in the building. The machinery required consisted of a large boiler, radiator, etc. The plumbing company guaranteed that the boiler capacity of the plant would be 4,800 square feet, that the amount of radiation would not be less than 2,345 square feet and that with five pounds of steam on the boiler a temperature of not less than 70 degrees in the rooms and 65 degrees in the halls would be maintained in zero weather. The company agreed to make good any defects which might appear in the plant within 12 months. It then ordered the necessary machinery from a radiator company, which shipped it direct to the plumbing company. On completion, a test of the plant developed the fact that the boiler was defective and the radiator company replaced it. Following on this the plumbing company went into bankruptcy. It had not paid for any of the machinery, so the radiator company took steps to create a lien upon the building and sued to enforce it. Its claim amounted to $1,096.56, subject to two credits of $108.81 each. The defense of the owners was that the heating plant failed to come up to the requirements of their contract with the plumbing company and that the materials furnished by the radiator company were defective and not reasonably fitted for the purposes for which they were intended. On these grounds they made a counter claim for $2,000 as damages. Judgment was granted for the amount sued for by the radiator company, but the owners were allowed $500 on their counter claim. Both parties appealed from the decision, which, however, was affirmed on appeal. It was held that there was an implied warranty that the machinery furnished was reasonably fit for its purpose. The evidence showed that the plant was defective and the building cold. It conflicted, however, as to the cause of this condition. The radiator company's witnesses testified that it was due to improper piping and insufficient radiation. Those for the owners testified that the radiation was entirely sufficient and that the trouble was caused by a defective boiler. The evidence being thus such as to leave the mind in doubt, the court followed the usual rule in such circumstances and refused to disturb the finding of the lower court.—*American Radiator Co. vs. McKee, Kentucky Court of Appeals.*

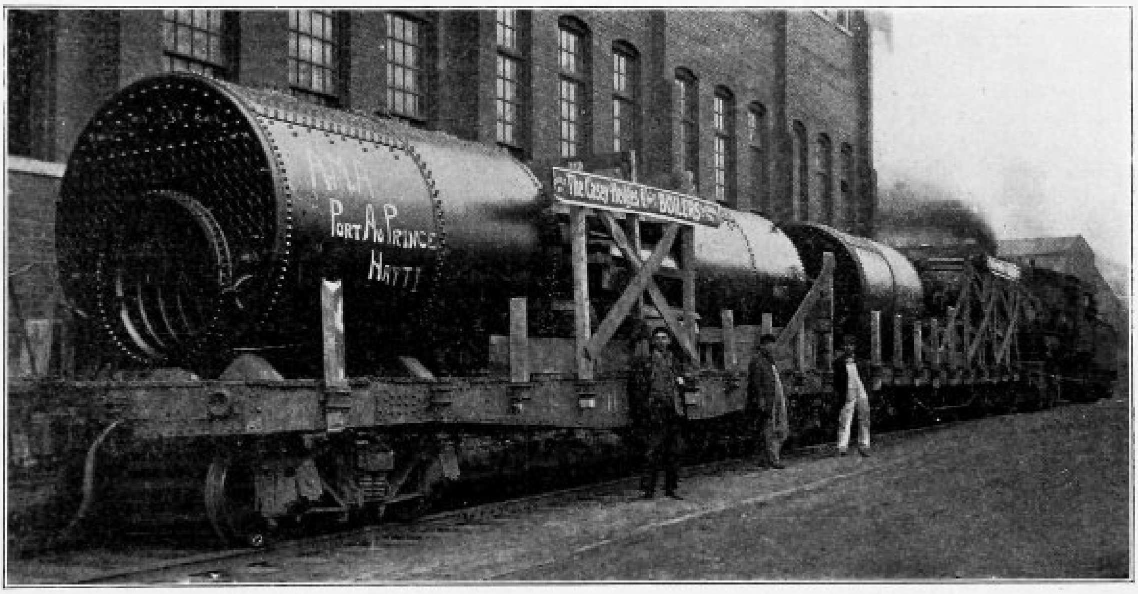
[EDITOR'S NOTE:—The above abstracts of legal cases of interest to boiler makers are the first of a series which will appear in our columns each month. These will all relate to current matters, and no attempt will be made to summarize decisions which have been made in the past.]

MODERN STEELS.

THE CARBON STEELS.

Steel is one of the most wonderful materials employed in the industrial world. Pure wrought iron contains no carbon. Starting from the point of a zero content of carbon and passing on up by small stages to a 2 percent content we obtain a very numerous series of metals. These are the *carbon steels.* Theoretically they contain nothing but iron and carbon. Practically, however, there is little or no steel of this character in the world. The reason is that the methods of manufacture combined with the character of the ores result necessarily, from a commercial point of view, in a final product containing more or less impurity. The other substances thus included are ordinarily manganese, sulphur, phosphorus, silicon. It will be seen then that the carbon steels may differ in the percentages in which such impurities occur. Consequently, if we consider not only the possible changes of the carbon content between 0 and 2 percent, but also the multitude of additional variations which may arise because of the impurity percentages, we readily see that the number of possible carbon steels will be enormous. Many of these varieties are, no doubt, useless from a commercial point of view. Thus, all the steels where the manganese content lies between, say, 2 and 7½ percent are well nigh useless products. But after all such exclusions are made, the residual series of carbon steels is rather a long one.

The effect of carbon is marvelous. When in maximum amount, it is only 2 pounds in a total of 100. We must not form the idea that steel is a chemical combination of carbon and iron. Such is by no means the case. There is a chemical compound of the two elements, known as *cementite* or *carbide of iron* (Fe_3C). It is not the steel; it is a component part of the steel. That is to say, steel consists of a mixture of cementite in the form of flakes or crystals intermingled with more or less pure iron. However, the carbon all occurs *combined* with iron. The iron occurs both combined and uncombined. In fact, if we could cut up a piece of steel just as we might wish, we could get bits of pure iron and bits of carbide of iron. It is wonderful, when we think of the minute quantity of carbon and of the additional fact that it is not distributed everywhere in the mass, to reflect on the change pro-



INTERNALLY-FIRED BOILERS, BUILT BY THE CASEY-HEDGES COMPANY FOR EXPORT.

American Boilers for Export.

The illustration shows three internally-fired boilers ready for shipment from the shops of the Casey-Hedges Company, Chattanooga, Tenn., to Port-au-Prince, Hayti. These boilers are 90 inches in diameter, with furnaces of the Morison corrugated type, 45 inches diameter and 12 feet long. Each boiler has eighty-six 3-inch tubes, 12 feet long, and the boilers are designed for a working pressure of 150 pounds per square inch.

The company which manufactures these boilers has recently been making extensive shipments to foreign countries of internally-fired and watertube boilers, using their various patent appliances on such boilers for burning refuse of practically all qualities. The three boilers shown in the illustration are to be fitted with the Casey-Hedges patent Dutch oven and casings, so that they will be suitable for burning the refuse common to a coffee plantation. Where boilers can be designed to use such refuse successfully there is a large saving in the fuel bill.

J. J. FLETCHER.

duced. If we add carbon from 0 percent up to about 0.90 percent we shall, on the whole, continually increase its tensile strength. The strongest carbon steel thus contains only about 1 pound of carbon in a hundred of steel. But even when the carbon is as low as 0.10 to 0.20 percent, we have a material different from wrought iron. Thus, pure wrought iron has a tensile strength of about 45,000 pounds per square inch, while such low carbon steels may have strengths of 50,000 to 60,000 pounds. These are wonderful results when we consider the very minute quantity of carbon. The general rule may be stated thus: Assuming pure iron to have a tensile strength of 40,000 pounds per square inch, we shall increase this strength 1,000 pounds for each 0.01 percent of carbon added. That is to say, given a piece of carbon steel having a certain strength we shall get a steel 1,000 pounds stronger by adding about 1½ ounces of carbon to 100 pounds of steel. The foregoing rule applies to steels made by the acid open-hearth process. If the basic open-hearth process has been used, then each 0.01 percent of carbon will add about 770 pounds to the tensile strength per square inch. If the steel has been made by the crucible process, then 1,000 pounds will probably not be quite enough to add; if the Bessemer process, then 770 pounds is probably too much.

The presence of impurities accounts, no doubt, for serious departures from this general rule. When we gain in tensile strength, however, we usually lose in ductility. The user of carbon steel has to bear this in mind. His use may permit a certain amount of sacrifice here.

Now some of the so-called impurities add, for certain applications, to the desirability of the steel. Sometimes the effect of small amounts is really inconsiderable. It all depends upon the use, etc. *Silicon* is thought to add but little to rolled steel. But its effect on the material in steel castings is quite marked. There is little or no loss of ductility, and an increase of 0.3 or 0.4 percent in tensile strength. This beneficial effect in castings is attributed to the influence of silicon in rendering the steel sound.

Even *phosphorus* is beneficial where the steel is to be applied only to certain uses. It produces a marked increase in the tensile strength. Thus, for each 0.01 percent of phosphorus up to 0.12, the steel will be 1,000 pounds per square inch stronger. But this resistance becomes effective only where the stress is applied with deliberation. For steel subjected to vibration and sudden shock, phosphorus is quite harmful.

Manganese seems, on the whole, to have rather a beneficial effect on steel when the percentage is quite moderate. It adds to the tensile strength, but in rather a complicated way, depending in part on the amount of carbon present. When manganese occurs in large percentages, say 7½ up to 20, we get a new product.

MANGANESE STEEL.

Away back in the eighties of the last century, the Hadfields in England were seeking a means of making steel castings stronger. The result of the experiments was the discovery of *manganese steel*. Now pretty much all commercial steel contains some certain small amount of manganese. But this is not what is meant by manganese steel. Nor are those steels meant which contain a larger percentage, say up to 7½, but which are very brittle. It was found that when a still larger percentage was present the steel changed markedly in character. Instead of being brittle, it was now tough. This is rather a curious result. There have been, however, one or two similar examples in the history of metallurgy. Further, the new material was found to be not only tough but hard. Manganese steel is about as hard as unannealed tool steel that has not been tempered. Further, it was found that it behaved peculiarly under heat treatment. When a piece of manganese steel was heated to a high temperature and then suddenly cooled, it was annealed. Quenching seemed to have just about the reverse result of what might have been expected. Another curious thing about manganese steel is that, when it is tested for its ultimate tensile strength, it will reduce in cross-section pretty uniformly over the length under test. Where fracture occurs, the reduction in area is not especially marked as with steel over the cross-section elsewhere. Even the castings made from manganese steel have the general properties. The elastic limit of manganese steel is not so very high, although its ultimate tensile strength is. It has been found almost impossible to machine it. The grinding machine has been found effective. Thus, the Ely-Norris Manganese Steel Safe Company builds a burglar-proof safe, in the manufacture of which they remove by grinding about 30 or 35 pounds of metal. This material has great resistance to wear and tear of certain kinds. For example, the Boston Elevated Railway Company experimented with a cast manganese steel rail on one of their sharpest curves. Here the life of an ordinary Bessemer rail was about forty-four days. The manganese steel rail, however, survived for 2,409 days and was then hardly worn out. The abrading action on the side of the rail head was, apparently, not withstood so well. But for resistance to the wear and tear of rolling action the manganese steel rail is superb. In fact, this material is being applied to many uses where shocks and friction have to be withstood. Switch points, the faces of crushing jaws, the lips of steam shovels, the face-plates of lifting magnets, are all examples of its applications.

SELF-HARDENING STEELS.

A British metallurgist, by the name of Robert Mushet, discovered a remarkable steel. Mushet steel contains both manganese and tungsten and a high percentage of carbon. The tungsten may be taken as ranging from 4 to 12 percent, and the manganese from 2 to 4. This steel cannot be made soft, so far as is known to the writer. It is a *self-hardening steel*. That is to say, if heated and allowed to cool slowly in the atmosphere, it will still be wonderfully hard. It is not a high-speed steel, although a tool of Mushet steel will take heavy cuts and will endure a long while without regrinding.

If, instead of manganese, we use chromium in combination with tungsten, we shall obtain another self-hardening steel. Or we may combine, in suitable proportions, manganese and molybdenum and produce still another self-hardening steel for tools.

HIGH-SPEED STEELS.

But modern research has revealed an improvement over the self-hardening Mushet steel. This is the *high-speed steel*. The first to bring out this product were, apparently, Taylor and White. This was about the close of the last century. High-speed steels are, then, but a few years old. Now they are indispensable materials in the up-to-date shop. There are many different varieties on the market to-day. The general principle which seems to underlie the composition of them is that there shall be a rather large percentage of tungsten present. The carbon may be considerably reduced, even to 0.60 or 0.70 percent. Manganese and chromium do not seem to be essential ingredients. Such steels are called high-speed steels because of their ability to cut metal at very high rates of speed. In fact, the speed and other conditions may be so great as heat the tool to redness. The hardness and toughness still remain, and the tool continues to do its work. The heat treatment is in general as follows: The tool is heated almost to the melting point, and then cooled at a moderate rate. Thus the heated tool may be exposed to an air blast. It may be allowed to cool naturally in the atmosphere without using

USED MACHINERY

IMMEDIATE SHIPMENT

POWER PUNCHES

Item.

287 Cleveland 90″ Multiple Punch, 12″ throat. Capacity thirty 13/16″ holes in ⅝″. Motor drive.
288 Whiting 48″ Stake Riveter and Punch. Capacity ½″ x ¾″ and ⅝″ cold rivets.
244 Hilles & Jones No. 3, 60″ Stake Riveter and Punch. Capacity ¾″ x 5/16″ and ⅞″ cold rivets. Motor drive.
294 Scully 12″ Horizontal Punch. Capacity 1¼″ x 1″.
490 Scully 24″ Architectural Jaw Punch. Capacity 1″ x 1″.

POWER SHEARS

483 Lennox Rotary Bevel Shear, No. 2, for ¾″ plate. Belt drive.
229 Long & Allstatter 48″ Gate Shear, 6″ gap. Capacity 3/16″. Belt drive.
291 Cleveland 10′ Gate Shear, 36″ gap. Capacity 3/16″. Motor drive.
59 Henry Pels & Company Johns Beam Shear. Capacity 12″ 35-lb. beams. Belt drive.
298 Thompson Bevel Shear. Capacity ⅝″ plate. Belt drive.
472 Hilles & Jones Double Angle Shear. Capacity 6″ x 6″ x 1″ angles. Weight, 20,000 lbs. Belt drive.

HYDRAULIC MACHINERY

265 Bement-Miles 8′ 6″ Riveter, 75 tons pressure.
263 Morgan 10′ 6″ Riveter, 100 tons triple pressure. R. D. Wood head.
266 Four column press, 175 tons pressure, 8′ 6″ x 3′ between columns. With dies.
267 Horizontal Punch, 12″ throat. Capacity 1″ x 1.″
268 Morgan 48″ Punch. Capacity 2″ x 1.″
269 Morgan 48″ Punch. Capacity 2½″ x 2.″
272 Morgan 10 ton Riveter Crane.
273 Bement-Miles 10 ton Riveter Crane.
262 Worthington Duplex Steam Pressure Pump, 18½″ x 3¼″ x 10″.

PLANERS

158 Pond, 26″ x 26″ x 6′, heavy pattern, one head. Belt drive.
215 Gray, 36″ x 36″ x 10′, two heads. Arranged for motor.
243 Ohio, 36″ x 36″ x 13′, one head. Arranged for motor.
163 Sellers, 36″ x 36″ x 7′, one head. Belt drive.
166 Bement, 36″ x 36″ x 7′, two heads. Belt drive.
167 Sellers, 42″ x 42″ x 6′ 6″, two heads. Belt drive.
169 Sellers, 42″ x 42″ x 8′ 6″, two heads. Belt drive.
137 Sellers, 48″ x 48″ x 8′ 6″, two heads. Belt drive.
285 Niles 20′ Plate Planer. Old style.
486 Newton No. 1, 26″ Rotary Planer. Motor drive.

LATHES

145 Flather, 14″ x 6′. Compound Rest, Power Cross Feed.
250 Flather, 16″ x 6′. Compound Rest, Power Cross Feed.
235 Hendey, 18″ x 10′. Quick change gear.
236 Hendey, 20″ x 18′. Quick change gear.
482 24″ x 10′ Muller. Compound Rest and Power Cross Feed.

DRILLS

Item.

195 Barr, three-spindle, sensitive.
198 Sigourney, four-spindle, sensitive.
396 Aurora Post Drill.
477 Lodge & Davis 30″, Sliding Head back geared.
479 Bickford 4-ft. Radial. Cone drive.

SHAPERS

183 Springfield 15″, single geared.
253 Steptoe 14″.
251 Smith & Mills 16″.

CRANES AND HOISTS

323 12′ Arm Traveling Wall Jib Crane. Hand travel. 3 tons capacity.
327 18′ Arm Jib Crane. 22′ mast. 3 tons capacity.
348 3-ton Yale & Towne Triplex Hoist.
351 8″ diameter, 9′ lift Quincy, Manchester, Sargent Co. Cylinder Air Hoist.
375 12″ diameter, 9′ lift Quincy, Manchester, Sargent Co. Cylinder Air Hoist.
365A 3-ton capacity 4 wheel trolley for 12″ I beam.
425 Northern Engineering Works 10-ton single motor trolley. Motor 2 phase, 60-cycle, 220 volt.
434 Reading 5-ton Hand Crane, 18′ span.
436 2-ton capacity hand crane, 15′ span.

ELECTRICAL EQUIPMENT

243A 5 H. P. Northern 250-volt D. C. Motor.
246 15 H. P. Northern 110-volt D. C. Motor, 1,200 R. P. M.
2A 15 H. P. Westinghouse 220-volt D. C. Motor, 560 R. P. M.
1A 25 H. P. Westinghouse 220-volt D. C. Motor 850 R. P. M.
381 7½ H. P. Lincoln Motor 3 phase, 60-cycle, 220 volt.
385 15 H. P. Lincoln Motor 3-phase, 60-cycle, 220 volt.
390 20 H. P. Lincoln Motor 3 phase, 60 cycle, 220 volt.
392 100 H. P. Fairbanks Motor 3 phase, 60 cycle, 220 volt.
240 Ohl 8′ Cornice Brake. No. 18 gauge.

MISCELLANEOUS

293 Robinson 8′ Cornice Brake. No. 20 gauge.
204 Brown & Sharpe No. 12 Plain Milling Machine.
201 Garvin No. 9 Plain Milling Machine.
213 Beaman-Smith No. 8 Horizontal Drilling and Boring Machine.
208 Pratt & Whitney No. 2, two-spindle profiling machine.
177 Ajax No. 5 Double Geared Bulldozer.
256 Binder No. 1 Cold Saw; 15″ beams.
238 Cosgrove Bending and Straightening Machine. Capacity 15″ I beams.
230 Allen 72″ Portable Pneumatic Boiler Riveter. Capacity 1¼″ rivets.
376 Municipal cube Concrete Mixer. Capacity ½ cubic yarp. With engine and boiler.
313 Merrill No. 5½ Pipe Cutter. Capacity 2″.
316 American Blower, 12″ outlet.
63 Bignall & Keeler, 2″ Pipe Cutter.
484 Hartz Flue Welder.
487 Ingersoll Sargent 8″ x 8″ Belt Driven Air Compressor.
488 2-B Universal Q & C cold saw.
491 Hanna 25″ reach 15″ gap 30-ton Riveter.
492 52″ Power Rolls 7″ top and 6″ bottom rolls.
493 17½″ x 15″ Allen Jaw Riveter for 1″ rivets.
497 1½″ National Bolt Cutter.

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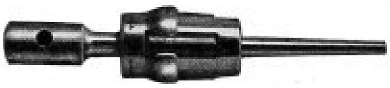
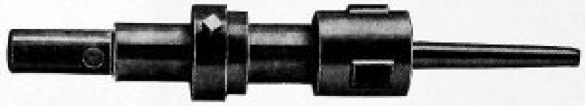


"Boss" Roller Expander (Hand Use)



Arch Flue Expander

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BOILER MAKERS' TOOLS

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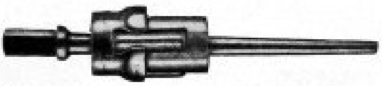
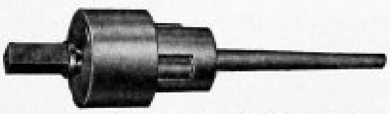
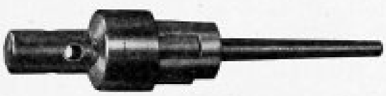


"Boss" Roller Expander (Self-Feeder).

Universal Expander (Hand Use)



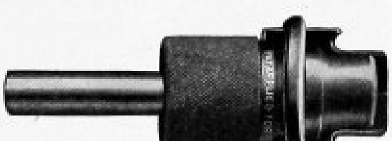
Universal Expander (Self-Feeder)



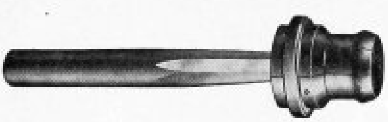
Removable Collar Expander (Hand Use)

Removable Collar Expander (Self-Feeder)

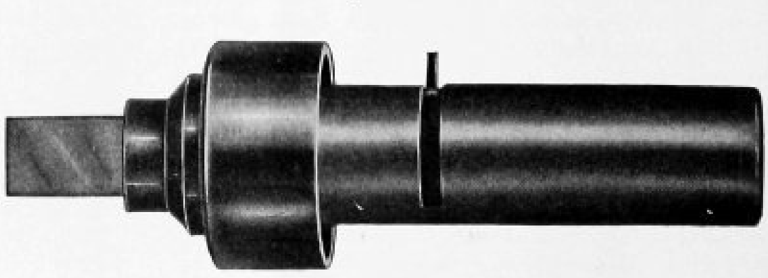
Rapid Beading Expander.



Rapid Beader Tool



Improved Sectional Expander



"Perfect" Flue Cutter

a blast. The blast seems advisable, however, to get the maximum hardness. Further, instead of tungsten, molybdenum may be employed. It is probable that many, if not most, of the high-speed steels contain chromium in addition to either tungsten or molybdenum. It is said, also, that both tungsten and molybdenum have been used in the same steel. It is said that the best amounts of molybdenum are in the range from 5 to 15 percent. In the United States, such molybdenum steels are patented.

As high-speed steels are hard at the lower heats it is found necessary to heat them up to the neighborhood of 2,000 degrees F. in order to forge them.

CHROME STEEL.

Chromium has been referred to as an ingredient in certain high-speed steels. It may be employed alone as an alloy of carbon steel. Its effect is to produce great hardness upon quenching. Such steel is not a self-hardening nor a high-speed steel. It has its uses, however. The elastic limit of chrome tool steel is higher than would otherwise be the case. This hardness is gained—as hardness is usually gained—by the loss of ductility. Chrome steel is very brittle. When applied to severe service, where there is liability to shocks, it needs support, which is sometimes given it by combining sheets of chrome steel with sheets of wrought iron. The wrought iron will still be ductile subsequent to quenching, while the chrome steel will be hard.

TITANIUM STEEL.

One of the new steels—though not a tool steel—is known as titanium steel. It may be that boiler makers may find this material worth investigating. Titanium is itself a metallic element. It is found alone nowhere in nature. However, there are large deposits of iron ore containing it in the Adirondack region in New York. The effect of titanium upon mild steels seems to be in the direction of hardness and toughness. Titanium steel seems to have a higher elastic limit and a higher tensile strength than the non-titanium carbon steel. Just how the titanium accomplishes its results is not very clear. It seems quite possible, however, that it is not so much that titanium adds to the steel as that it clears the way for the carbon and iron to produce their effects. In other words, it is possible that titanium may be found to be principally a *purifier* of steel. If this should indeed be its chief office, then it would seem a very desirable ingredient in almost any steel. Titanium mild steel appears to be somewhat similar to manganese steel—though probably not so hard and tough. It has been under investigation as a rail steel. An example of a considerable experiment along this line was the comparative test of titanium steel rails and Bessemer steel rails at Kessler's Curve on the Baltimore & Ohio Railroad, in the Cumberland Division. The traffic here was quite heavy. The titanium steel rails had only a 0.48 percent carbon content against a 0.55 percent carbon content of the Bessemer rails. On Oct. 7, 1908, seventeen rails of the special steel were laid and seven of the ordinary kind. At the end of nine months the former were found to be only about half worn out, while the latter were about at the end of their life. The results of abrasion were 1.61 percent for the titanium steel rails and 4.64 percent fo the Bessemer rails. Titanium has a great affinity for oxygen and nitrogen, so that it may be because of this that such results are due. An extensive series of tests were made upon titanium steel specimens. The carbon content ranged from 0.52 to 0.55 percent; the sulphur from 0.38 to 0.57 percent; the phosphorus from 0.095 to 0.099; the manganese from 0.82 to 0.88; the silicon from 0.130 to 0.165. Forty-two tests, six from each of seven heats, gave elastic limits ranging from 78,930 pounds per square inch to 95,010 pounds; and ultimate strengths ranging from 108,900 pounds per square inch to 124,170 pounds. There is a large increase here in the ultimate strength over the ordinary Bessemer rail steel, and the elastic limit is undoubtedly raised. Calculating Bessemer 0.55 carbon steel by the rule elsewhere given in this article, we get 82,350 pounds for its tensile resistance. It will be seen then, if the comparison is correctly made, that titanium steel promises very considerable tensile results. The fact that the increase in tensile strength has been accompanied by an increase in the elastic limit is important. We thus get resistance to deformation and ultimate strength at the same time. It would seem that experiments with railroad rails also throws some light on this matter. If one glances over the rail sections prepared by a prominent engineering firm in New York, and showing results of the nine months' wear at Kessler's Curve, he may notice that some of the Bessemer rails disclosed a very distinct tendency to flow—some had even crushed places. The special titanium steel, however, disclosed but very little tendency to flow. As a rule, the rail head was simply worn. The amount of this wear, as we have before seen, was very much less than with the Bessemer rails. Now, if indeed we have here a metal having greater ultimate strength combined with a higher elastic limit, it would seem that we might have in it a material suitable for rivets. Moreover, it so happens that titanium steel is not an expensive article. Indeed, the titanium treatment can be applied for about $1.30 per ton. So that, if after actual experimentation titanium steel should be found to be an excellent riveting material, the increase in cost would be negligible. Furthermore, the addition of titanium does not produce a material, like manganese steel, difficult to machine; although this would have no effect upon the manufacture of rivets.

The application of titanium to steel is not made direct. It would probably be an exceedingly expensive thing to produce pure titanium. Furthermore, such application would probably be a difficult procedure. Instead, the practical and the commercial way is to use a titanium alloy. This is precisely the method employed with manganese. That metal is not added direct, but by means of an iron alloy. The effect of properly applied titanium is said to be a retardation of the "segregation of sulphur, phosphorus and carbon in what is normally quiet, quick-setting steel." The steel becomes sound. That is to say, the blow-holes instead of being distributed throughout the mass are confined mostly to the region where the pipe is formed, and which goes into the discard. There does not appear to be any lessening of the pipe. The remainder of the steel is rendered sound. It is said, also, that titanium steel works better in the rolling mill. In this respect it is in strong contrast to manganese steel. The latter presents an exceedingly difficult problem to the rolling mill. So much so is this the case that manganese steel rails cost upwards of about eight times as much as titanium Bessemer rails—the difference being largely due to the problem of rolling. Boiler makers might, perhaps, very well consider whether they have not in titanium steel a better material than that ordinarily used.

It is surprising what a minute quantity of titanium accomplishes the results. The alloy itself contains titanium in a percentage of about 10 to 15. Of this allow, a quantity amounting to only 0.3 percent of the steel to be treated is added to the flowing metal as it comes from the Bessemer converter or from the open-hearth furnace and goes into the ladle. In three to six minutes the chemical changes are sufficiently complete and the impurities have escaped. Titanium has an avidity for oxygen and nitrogen. It no doubt accomplishes its results largely through eliminating the usual effects of these gases, and not so much through the presence of itself in the constitution of the steel. In other words, it acts perhaps as a "scavenger." Be that as it may, there seems good ground to believe that the steel is benefited as to its tensile strength and as to its elastic limit. If there are no offsets to such benefits it would seem that all mild steels might well be treated with titanium—boiler plates, rivet steel, etc., etc.

VANADIUM STEEL.

There is another steel which seems to owe its qualities to a very minute amount of a third element. This is *vanadium steel.* If only about one-eighth of 1 percent is added to the steel some effect is accomplished. The maximum amount that it seems desirable to add is only about one-third of 1 percent. It seems, therefore, about as remarkable an element as carbon in its effect on steel. Now, vanadium, like manganese and titanium, is found nowhere alone in nature. But this presents no difficulty to the steel maker.

Vanadium steel has been found to possess some remarkable qualities—*when its heat treatment is right.* Thus vanadium steel has been made and treated whose tensile strength was found to be 240,975 pounds per square inch. This is an enormous strength. It means that a vertical rod having a cross-section of an inch would support a load of upwards of 120 short tons. But this is not the whole story. The same sample of steel was found to have an elastic limit of 225,000 pounds per square inch. This is, perhaps, more remarkable still. It would seem that such qualities would pre-eminently fit vanadium steel for rivet steel. If such should indeed be the case, and this material found to be all that such enormous values for tensile strength and elastic limit indicate, then we could safely diminish the cross-section of rivets. This would make the parts riveted stronger because of smaller holes. In short, with such a material many changes could be made in machines and other industrial and engineering applications. Of course, all this turns on the question whether vanadium steel has any offsetting qualities and whether it can be depended upon to remain in the same condition.

It is remarkable how profound is the influence of the heat treatment upon vanadium steel. Thus in forty tests made with steel from the same heat there was disclosed a range of tensile strength from 83,500 pounds per square inch to 240,975 pounds. This is an enormous variation. But the range in the elastic limit was found to be about as great—50,500 to 225,000 pounds per square inch. The heat treatment is evidently of a vital character. According as it is applied in one way or another, the tensile strength may vary from an ordinary amount to nearly three times as much. The maximum elastic limit may be over four times as great as the minimum. If the higher values are to become the bases of the strength and capacity for service of boiler plate and rivet steel, then the success of the heat treatment must be thoroughly dependable. If any doubt hangs over this point then only the more moderate values could be used.

Vanadium steel has been tested in vibration. A stay-bolt was put into a vibratory machine and "ran 474,001 revolutions." The test covered six and one-half days. The bolt was not broken. It was then tested tensionally. The yield point was found at 92,280 pounds per square inch, the tensile strength at 111,550 pounds. There was no elongation, and the reduction in area was 1.2 percent. It is said that ordinary stay-bolt iron yields to the vibratory test with 5,000 to 20,000 revolutions.

These are, no doubt, remarkable results in favor of vanadium steel. It would seem to merit a very thorough investigation on the part of boiler makers and others.

New President of the Mechanical Engineers Society.

Col. E. D. Meier, president of the American Boiler Manufacturers' Association, has just been elected president of the American Society of Mechanical Engineers.

LAYOUT OF A TAPER SHEET.

BY JOHN V. PETTY.

The following describes a method of developing the tapered surface of the frustum of a right circular cone and is adapted to the case where the taper is small, or when, owing to the large radius, it is found impractical to locate the common center for the two curves and then draw these curves in the usual manner.

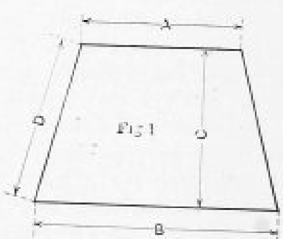
Given a taper course with dimensions *A, B* and *C*, as shown in Fig. 1, draw Fig. 2 similar to Fig. 1, making *A'* equal to 3.1416 × *A* divided by *N*, and *B'* equal to 3.1416 × *B* divided by *N*, where *N* equals the number of plates to the ring. (The method holds good for any division of plates.) The value of *D*, the slant height of the frustum, remains the same. This value may be found by sketch or calculation. The formula is *D* equals

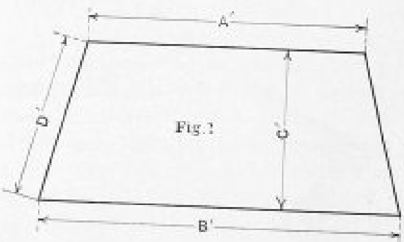
$$\sqrt{\left(\frac{B-A}{2}\right)^2 + C^2}$$

Now obtain the value of *C'*, either by sketch or calculation. The formula is *C'* equals

$$\sqrt{D^2 - \left(\frac{B'-A'}{2}\right)^2}$$

If the height of the course must not be exact, as in the taper sheets for stacks, etc., it would be all right to make *C'* in Fig. 2 equal to *C* in Fig. 1, thus eliminating considerable calculation. It must be decided in each case whether the job will permit of this small error in height.





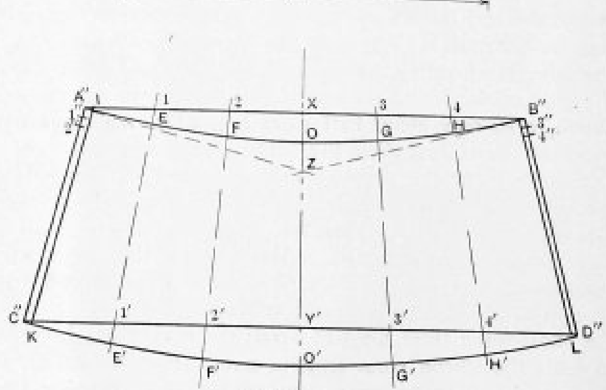


Fig. 3

Having found the necessary measurements from Fig. 2 the next step is the actual layout of the plate. Transfer Fig. 2 to full-size scale on the plate, as represented in Fig. 3. Bisect the figure with a vertical line, meeting *A″ B″* at *X* and *C″ D″* at *Y*. From *A″* erect a line perpendicular to *A″ C″* intersecting *XY* at *Z*. From *B″* erect a line perpendicular to *B″ D″* intersecting *XY* at *Z*. The intersection of the two perpendiculars and line *XY* at the common point *Z* will test the accuracy of the work thus far. Locate point *O* on *XY* equidistant from *X* and *Z*. Then *XO* equals the height of the chord of the arc of the upper curve, which in boiler shops is commonly known as the rise or camber.

The points *A″*, *O* and *B″* are three points on the upper curve. To locate more points on the curve proceed as follows: divide *A″ B″* and *C″ D″* into any even number of equal spaces, depending upon the number of points required to locate an accurate curve. Make the same number of divisions on each line. In this case six divisions are chosen, locating points 1, 2, 3, 4 on *A″ B″*, and 1′, 2′, 3′ and 4′ on *C″ D″*. Join these points together by lines, producing them a little below *C″ D″* as shown. With a pair of dividers set to the spacing one-third *XO* step off two of these spaces from *A″* on *A″ C″*, and two more spaces from *B″* on *B″ D″*, locating points 1″, 2″, 3″ and 4″. Lay a straight edge on points 1″ and *O* and draw that part of the line which intersects line 1-1′, locating point *E*. Then lay the straight edge on points 2″ and *O* and draw that part of the line which intersects line 2-2′, locating point *F*. Likewise the intersection of line 3″-*O* with line 3-3′, and line 4″-*O* with line 4-4′ locates points *G* and *H* respectively. Then *E, F, G* and *H* are additional points on the upper curve. Draw a smooth curve through the points thus found, locating the upper curve.

With a pair of trammels set to the distance *A″ C″* strike off this length downward on each of the radial lines from the point previously located on the upper curve, locating points *E′, F′, O′, G′* and *H′*. Points *C″* and *B″* were previously located. Draw a smooth curve through the points thus found, locating the lower curve.

Measure along the upper curved line on each side of *O* a distance equal to one-half *A″ B″*, locating points *I* and *J*. Measure on the lower curved line on each side of *O′* a distance equal to one-half *C″ D″*, locating points *K* and *L*. Join *I* to *K* and *J* to *L* by lines. Then *IOJLO′K* are the center lines for the rivet holes on the required development. With the necessary addition for laps the layout is complete.

The taper shown in the sketches was made larger than usual, so as to make the method of laying out more apparent.

NO CHANGES IN MASSACHUSETTS BOILER RULES.

After a lengthy and somewhat stormy public hearing on November 3, the Massachusetts Board of Boiler Rules decided not to make any of the changes proposed in the petition before it. This petition represented the wishes of five of the chief boiler-making concerns in Massachusetts, their case being presented to the board by Fred N. Dillon of Fitchburg. Discussion of the petition, in which various representatives of the operating engineers took the largest part, was devoted mainly to the matter of securing safety, both for the sake of the operating engineer and for the "innocent public." There was also a discussion of the effect on boiler-making practice and on the safety of boilers, which brought out some rather interesting information in regard to the practice of steel mills in making fire-box plate of certain required quality. The effect of a slight increase in allowable tensile strength on the safety of the boiler was argued pro and con without disclosing the fact that the increase asked for by the manufacturers would not substantially diminish the safety of boilers under the supposed specification. The changes proposed were the following:

1. Page 47, paragraph 67, relating to the suspension type of setting boilers. Amend to read: "that the outside suspension type of setting may be optional."

2. Page 40, paragraph 32, relating to bracing around manhole in front head under the tubes. Amend by adding the words: "or the front end of the stays may be attached to the front head in a similar manner as to the rear head," and further amend by striking out entirely the last paragraph relating to location of such stays.

3. Page 46, paragraph 60, relating to manhole in front head under the tubes. Amend by substitution complete of the following words: "the placing of a manhole in the front head, below the tubes, of a horizontal return tubular boiler shall be optional."

4. Page 21, paragraph 5, relating to physical properties of steel. Amend by substituting the figures "55,000 to 65,000" tensile strength for fire-box steel in place of the figures "52,000 to 62,000."

5. Page 21, paragraph 3, relating to chemical properties of steel. Amend by recommendation that no quality of steel shall be used of a less composition than required of fire-box, or amend by stating that on and after January 1, 1912, no flange steel shall be allowed in any plate, or head of a boiler.

6. Amend the same paragraph by making the acid steel contain only the same amount of phosphorus as in the basic process.

7. Page 12, paragraph 1, section 6, relating to hydraulic pressure. Amend by addition to read: "that the minimum pressure shall be one and one-fourth (1¼) times."

8. Page 31, paragraph 4, relating to steel angles to brace heads of 30-inch boiler. Amend by additions of examples, or rules for 125-pound and 150-pound pressures. Also same for boilers 36-inch diameter.

9. Page 48, paragraph 9, relating to feed pipe. Amend by eliminating from the first paragraph the words (after the word "when," on fifth line) "the diameter of the boiler exceeds 36 inches and". Also amend by addition at the end: "This rule does not apply to boilers 36 inches and less in diameter."

10. Also advise the best method of feeding water into boilers of 36 inches diameter and less when made for working pressures exceeding 25 pounds and not having a manhole.

The most interesting item from the point of view of the boiler manufacturer was perhaps the fourth proposed change, which raised the maximum allowable tensile strength from 62,000 to 65,000 pounds for fire-box steel. As the boiler maker, of course, knows very well the difficulty with the Massachusetts standard is that the steel mills often have a great deal of trouble with the 4,000 pounds or thereabouts, which they allow themselves as a margin in manufacturing plates, in turning out plates that are reasonably within the limit. Geo. H. Lloyd, representing the Central Iron & Steel Company, who was present at the hearing, said that when his mill had to supply steel at 58,000 pounds tensile strength the mill lost a great many plates by having to work within a close margin; and that the mill had at times refused to supply plates within that small limit because of the uncertainty of getting them with a reasonable expenditure of material.

Mr. Stevens of the board related his experience and observation in a recent visit to Germany, where, he said, he found that for fire-box steel a theoretical maximum of 56,000 pounds was considered the highest limit compatible with safety. The German "Blue Book," which takes in every pressure vessel, specifies 56,000 pounds, and a government permit is required for the use of steel of a higher tensile strength. The idea is, of course, that as the tensile strength is raised the liability of boilers to cracking is increased; the German view was that a boiler had better stretch than burst. Probably all boiler manufacturers will agree with this, but it is tolerably clear that even if the tensile strength were allowed to go 3,000 pounds higher than is now permitted the elastic limit and the ductility with the higher limit would amply assure the safety of boilers under working conditions.

Mr. Dillon in behalf of the manufacturers said that it was not proposed to depart from the elongation, ductility and chemical character specified in the present rules. Plate of a little higher tensile strength, he said, would give a boiler a little higher working pressure; and because with the higher tensile strength a slightly thinner plate could be used the proposed plan would avoid some trouble from fire cracks which occur in the plates now specified. He declared that the manufacturers were not asking for lower quality of plate but for an equally good plate that it would be easier for them to get from the steel mills. In reply to the suggestion of the chairman of the board that the makers would save by using acid steel of the specified quality ought to get the benefit of his good luck. This point was frankly a business proposition, but it was contended that there was no good reason for not granting it, since Amendment 5 would make the acid steel of just as high quality as the basic.

Amendment 1 rested solely on business reasons. It had been found in some plants that where additional boilers were to be installed they could not be put in with the outside suspension type of setting as now required without shifting all the boilers in the plant. Naturally, very little argument was made in favor of this change.

The main point in Amendment 2 was really the matter of placing boiler stays. The present rule requires stays between the heads on each side of and above the center line of the manhole in the front end below the tubes. Designers frequently carry the tubes so low that the stays cannot be placed in the required position, and this was given as the reason for seeking to have this part of the rule struck out. The operating engineers, as well as the chairman of the board, quickly raised

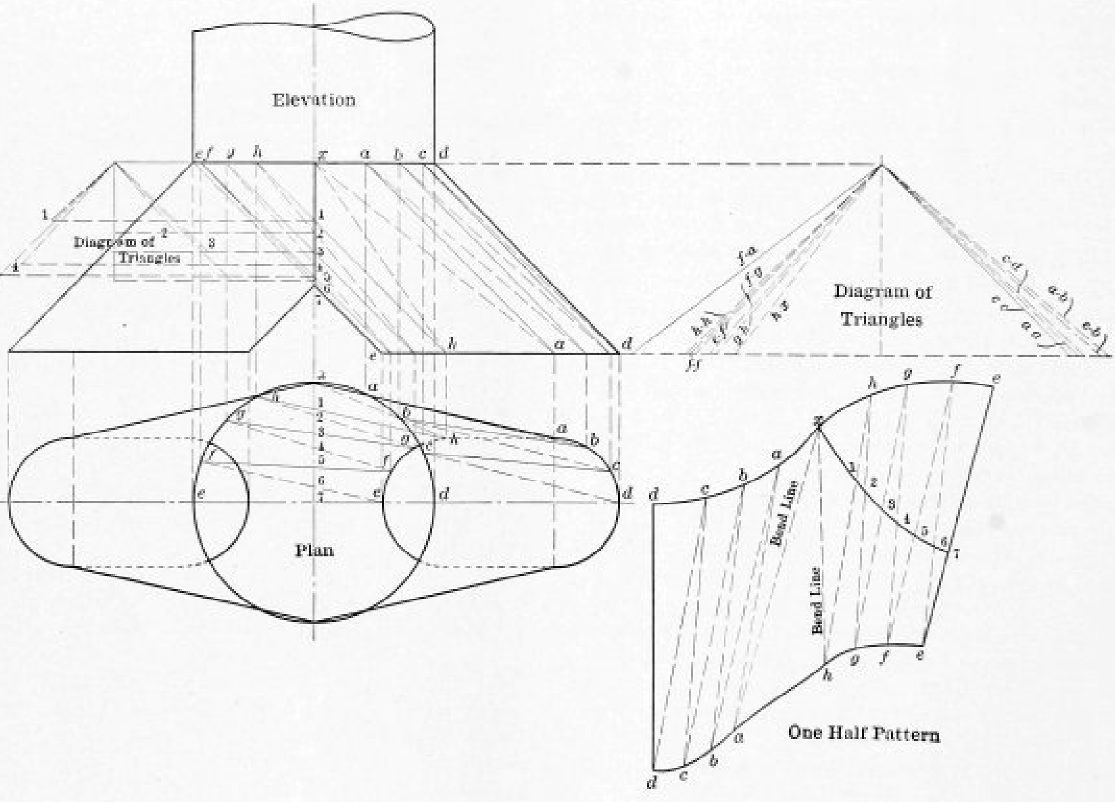


FIG. 1.—PLAN, ELEVATION AND PATTERN FOR AN ELLIPTICAL Y-PIPE CONNECTION.

thinner plates in consequence of higher tensile strength, Mr. Dillon said that the difference in cost due to lessened weight would be trivial.

Amendments 5 and 6, it would seem, might well enough have been allowed, since by excluding flange steel they were in the direction of requiring better material for all parts. In regard to the phosphorous content of acid steel, discussion brought out the fact that the requirements of the Massachusetts rule for acid steel were so severe that basic steel was almost entirely used for Massachusetts boilers. By the acid process it was very difficult to get the phosphorus down to .04 percent, as is required by the rules. Nevertheless, boiler makers do occasionally get acid steel of that quality, and Mr. Dillon said that when a boiler designer specifies acid steel of the same phosphorus content as the rules prescribe for basic steel, he thought the manufacturer who happened to have the objection that lowering the position of the stays would weaken the boiler head; and also that the first change sought by Amendment 2 would leave the rules entirely without any specification as to the manner of fastening the stay rods at either the front or rear head.

The strongest opposition from the operating engineers was brought out by Amendment 3. In regard to this it was argued quite soundly that a boiler which could be thoroughly inspected from the inside could be kept in much better condition and kept much safer than one which could not be so inspected. The argument in favor of the proposed change was little more than one of convenience for the manufacturer, and it naturally did not get very respectful attention.

Amendment 8 raised much the same kind of question as the item just discussed. The present rules allow steel angle bracing of the front head of 30-inch boilers only for pressures of 100 pounds and below, and the proposed change seemed to be an attempt to allow this method of bracing with pressures of 125 and 150 pounds. The chairman of the board declared emphatically that there was no inclination on the part of the board to permit a higher pressure than 100 pounds with angle bracing. It was open to the manufacturer to put in a manhole so that he could use radial bracing; and, in fact, radial bracing had been used in boilers without any manhole.

In regard to Amendment 7 it appeared that the Massachusetts boiler inspectors are left to their own judgment as to whether they shall employ any hydrostatic test whatever on a particular boiler. And there was practical agreement, apart from the position of the manufacturers, that a good many boilers would be spoiled by the proposed minimum water pressure that were perfectly safe under the working steam pressure allowed to them by the State inspectors.

The suggested change as to feed pipe was strongly opposed, because under the amended rule a feed pipe might be made to depend for support wholly on the threads of an opening in the head or shell. The amendment would remove from the present rule the requirement that "the feed pipe shall be carried through the head or shell with a brass or steel boiler bushing (or the opening reinforced), and securely fastened inside the shell above the tubes."

Amendment 10 was designed to remove certain items of doubt in the way the State inspectors now interpret the rules of the board.

TO DEVELOP REGULAR AND IRREGULAR Y-PIPE CONNECTIONS.

BY C. B. LINSTROM.

The forms of Y-connections or breechings generally encountered in sheet metal work are shown in Figs. 1, 2, 3 and 4. Figs. 1 and 2 are irregular and require a more extensive and complicated method of development than is required for Figs. 3 and 4. The general arrangement of Figs. 1 and 2 shows that all lines assumed on the drawings are foreshortened, which is due to the irregular taper in Fig. 2 and the irregular taper and shape of the leg openings in Fig. 1. Owing to the above conditions the practical method of laying out the

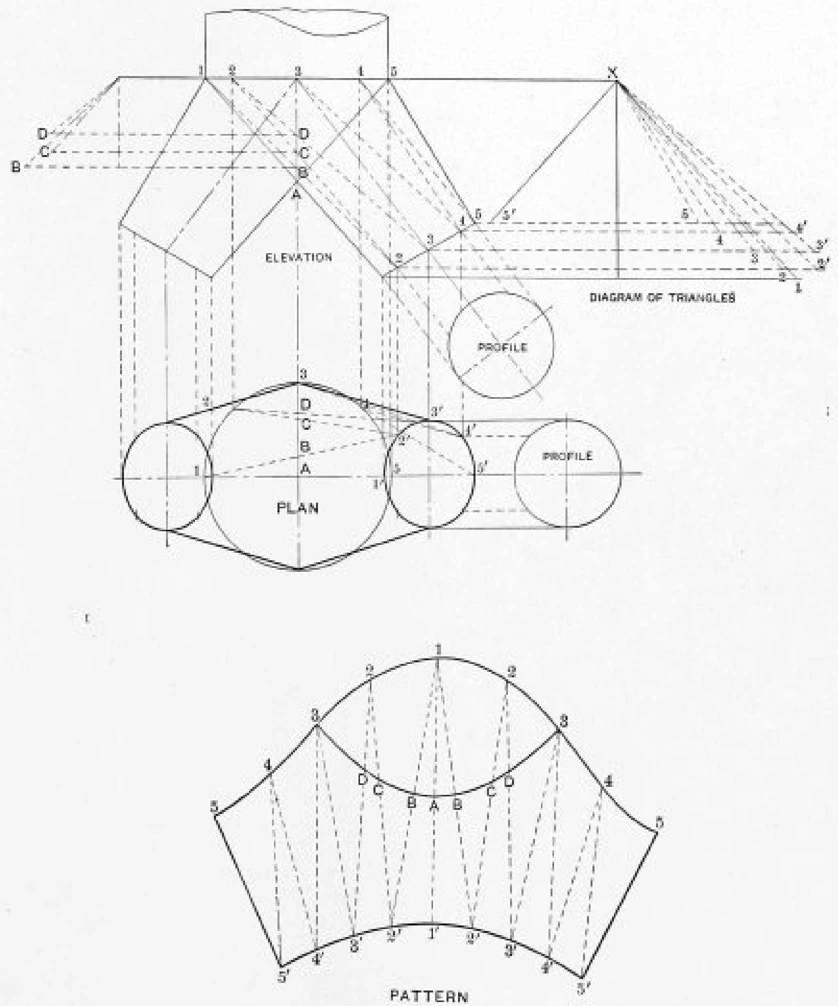


FIG. 2.

constructions for Figs. 1 and 2 is by the triangulation system.

Fig. 3 is regular in outline and is introduced for the purpose of showing the principles involved in obtaining correct mitre lines and patterns by the parallel method for intersections between cylinders which are shown in their true length in elevation. There are numerous varied modifications of this construction in pipe work, but the development remains practically the same if the arrangement of the pipes is regular. The term "regular" in this case means that all construction lines assumed on the surface to be developed are shown in their true length.

Fig. 4 involves the radial and parallel method of development for its solution. Fig. 2 is a modification of this construction.

CONSTRUCTION OF FIG. 1.

The first operation is to draw the plan and elevation in their relative positions and to the required dimensions. In this construction a flat surface is shown from *a* to *x*, and *h* to *x*, in the elevation. The major diameter of the oval openings is usually made equal to the diameter of the large pipe.

Divide the semi-circle *a* to *d* of the plan view (Fig. 1) into any number of equal spaces, in this case three, as shown, from *a* to *b*, *b* to *c*, and *c* to *d*. Project these points of division to the line *e* to *d* of the elevation. Parallel to the outside border lines of the Y-legs and from the points just located on the line *e* to *d* draw solid lines until they intersect the line of intersection between the large pipe and the Y-legs. These points are then dropped to the plan view. In order to avoid confusion alternate dotted and solid lines should be drawn. Solid lines connect the points *a* to *a*, *b* to *b*, *c* to *c*, etc. Dotted lines connect the points from *a* to *b*, *b* to *c*, *etc.*, corresponding dotted lines can be shown in the elevation if desired; this, however, is not essential, as these lines serve no purpose other than they may aid in checking up the drawing.

Having drawn in all the construction lines, the next operation will be to obtain their true length. This is done in the usual manner by constructing triangles, the bases of which are obtained from the plan view and the corresponding heights from the elevation. The diagram of triangles shown to the right of the elevation is used for developing the whole leg of the Y shown within the limits of the boundary lines *e* to *e*, *e* to *d*, *d* to *d*, and *d* to *e*. To obtain the throat connection, or the line of intersection between the two branches of the Y, it is necessary to determine the true length of lines shown within the section *e* to *x* to 7 of the elevation. The true lengths of lines are constructed as drawn to the left of the elevation. The bases are equal to the distances *e* to 7, *f* to 6, *f* to 5, *g* to 4, etc., of the plan view. Their heights are obtained from the elevation. The line connecting the base with the height is the hypotenuse, or the required true length of line.

Having now sufficient information for developing the pattern it can readily be constructed as follows:

Set the dividers equal in length to the distance *d* to *d* in the elevation, then draw a line of indefinite length and upon it locate the distance *d* to *d*. Then with the dividers set equal the space *d* to *c* of the oval opening plan view and, using *d* as a center, shown at the bottom of the pattern, draw an arc. Set the dividers equal the space *d* to *c* of the large circle plan view, and with point *d*, shown at the top of the pattern, as a center, draw an arc. The corresponding true length of line *c* to *d* is then transferred to the pattern. Continue in this manner, using alternately the true spaces solid and dotted construction lines until the pattern is complete.

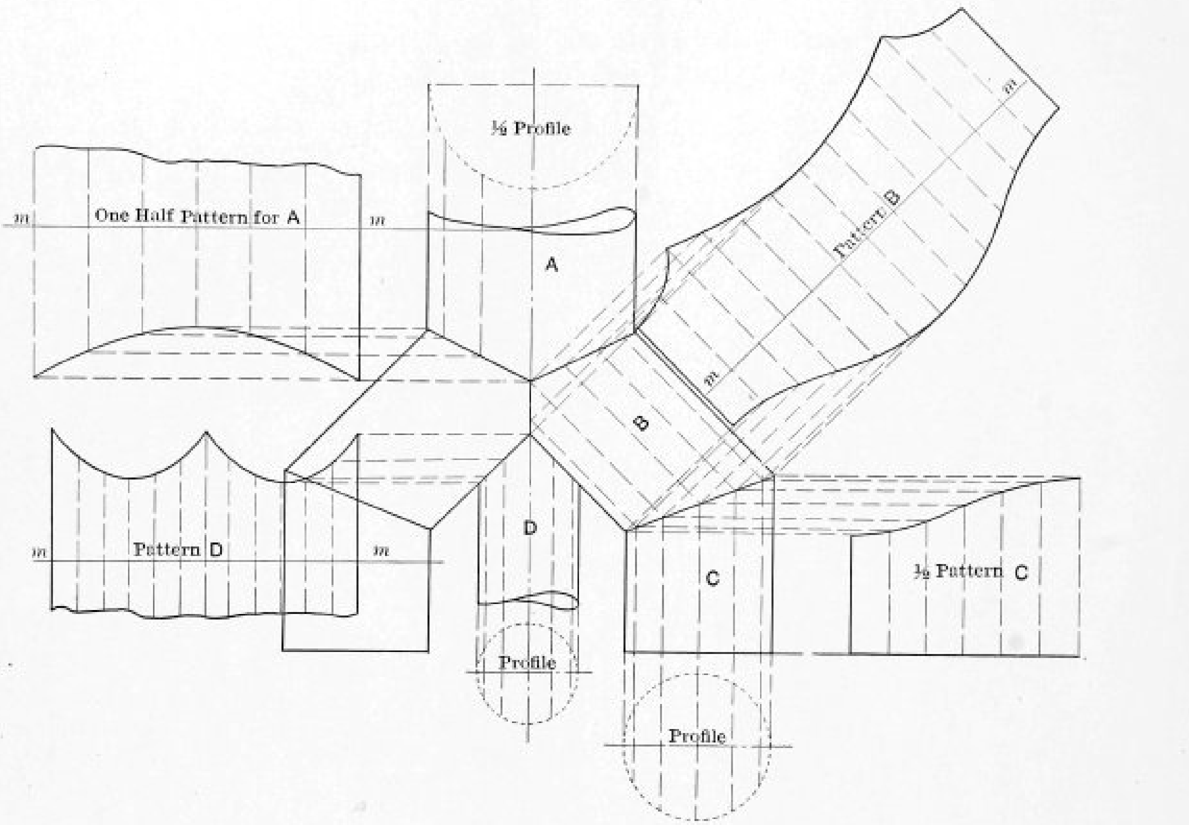


FIG. 3.—Y-PIPE CONNECTION DEVELOPED BY THE PARALLEL METHOD.

The vertical or throat connection between the two branches of the Y is determined in the manner as set forth in the pattern. The distances between the points *h* to 1, *h* to 2, *g* to 3, and *g* to 4, etc., are transferred from triangles shown to the left of elevation to the pattern.

This problem and the one shown in Fig. 2 embody conditions which necessitate the principles of triangulation drawing for their proper solution. The errors which are noticeable in this method of development are not very great, unless the curvature of the surface is large. The system, as a whole, can be relied upon, and if very accurate construction is required a greater number of triangles can be drawn, which will reduce the errors to a minimum.

Fig. 4 is a construction in the form of an intersection between two right cones and a cylinder. The cones are tilted, so to speak, until their axes make the required angle with the axis of the cylinder. The development of this connection is as follows:

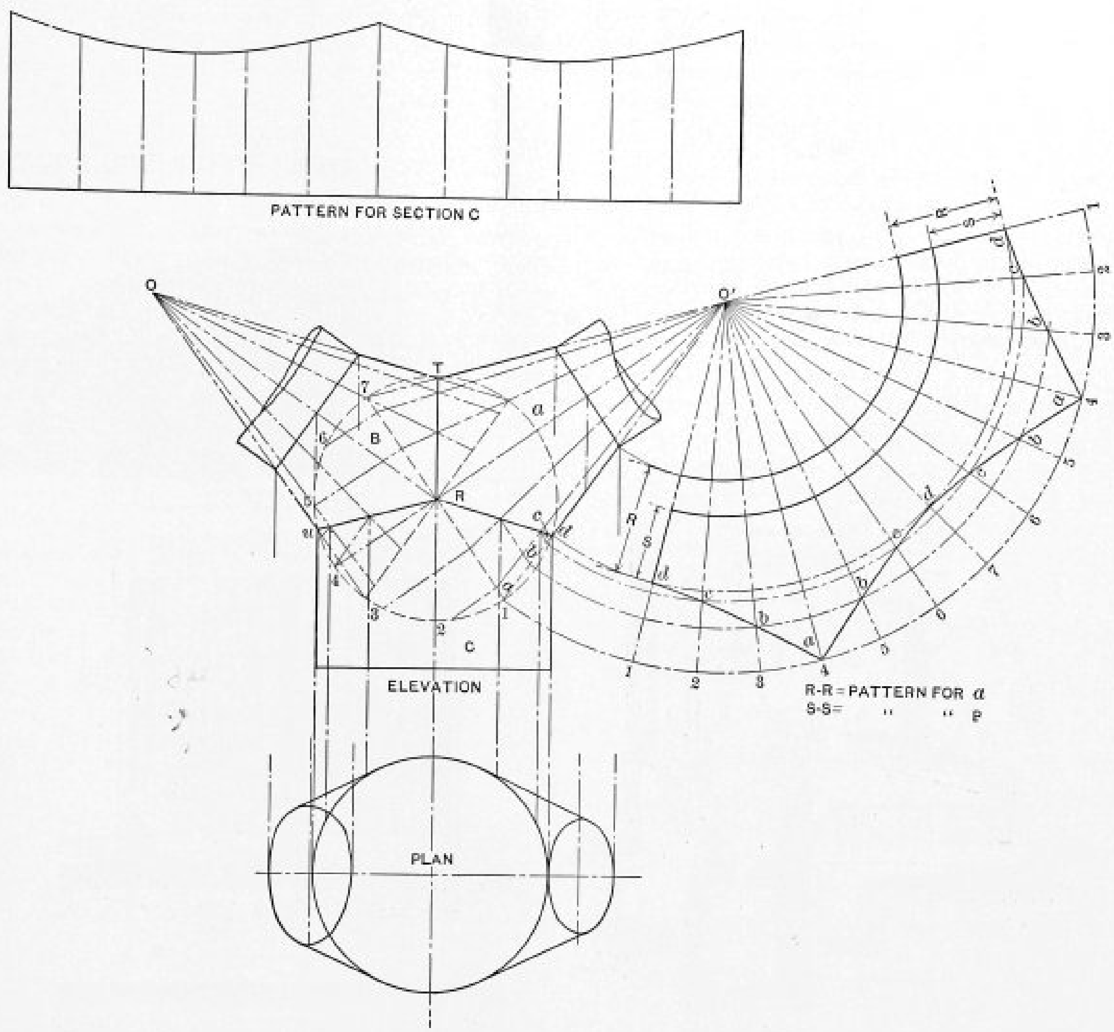


FIG. 4.

First draw the center lines or axes of the three connections to the required angles between them. Through the apex *R*, which is the point where the axes meet, and at right angles to the center lines of the respective sections, draw the required diameter of the bases. The bases of the cones are made slightly larger than the diameter of the cylinder, as will be noted. After the bases of the cones have been properly located on the drawing, their extremities are then connected with points *O and O'*. Using point *R* as a center, and with a radius equal to one-half the diameter of the cone base, draw a semi-circle. Divide its periphery into any number of equal divisions and extend these points to the base line of the cone. The points located on the base line are then connected with the apices *O* and *O'*. These lines are termed the elements of the cone.

The next operation is to determine the proper mitre lines between the three sections. In this case the lines of intersection between them center at point *R*. The mitre connection between the two cones is established through the intersection of their outer elements, as shown at *T*, and the intersection between the cones and cylinder is fixed where the outer ordinates intersect the lower element of the cone, as shown at *u*. Points *u* and *T* are then connected with *R*, which gives the line of connection between the intersections.

Before the patterns can be obtained for the conic sections, it will be necessary to find the true length of the elements within the outer boundaries of the cones, as it is understood in all radial developments that the measurements of points and lines are determined by means of their elements. The true lengths of the elements *b* and *c* are obtained in the manner as set forth in the elevation, where the points *b* and *c* are found by projecting lines at right angles to the axis of the cone through the point of intersections between the elements and mitre line to the outer edge line of the cone.

To develop the patterns for sections *A* and *B*, first draw a circular sector with a radius that equals the slant side of the cone; the arc is equal to the circumference of the base of the cone. Divide the sector into halves, and on either side of the point 7 on the arc of the sector step off the same number of equal spaces as contained in the semi-circle, which represents one-half the base of the cone. Radial lines are then drawn connecting the points of division with *O'*, as shown from 1 to *O'*, 2 to *O'*, 3 to *O'*, etc. To establish the line of connection simply revolve the points *a, b, c* and *d* around to the pattern until they intersect their corresponding lines. A line traced through the intersection of these lines gives the required mitre line.

An explanation for laying out the pattern for section *C* will not be given, as the drawing is sufficient to make clear the reqirements.

CONSTRUCTION OF FIG. 3.

Draw the elevation and profiles in their relative positions. The location of the mitre lines between the upper throat and the connections between the section *B* to *C* and *D* are to be made to suit the requirements. Divide the profile into any number of equal spaces. Drop these points of division to the line of connection between the large pipe and the Y-branch. In a like manner divide the remaining profiles and draw the construction lines as shown within the sections *B*, *C* and *D*. These projections are the true lengths of the required lines, which are used for developing the patterns.

Having determined these lines, the patterns are very easily constructed in the following way:

A stretch-out line, *m* to *m*, is first drawn, and which is equal in length to the distance around the pipes; this distance is obtained by multiplying the diameter by the constant 3.1416. Divide this stretch-out into quarters, and these divisions into the same number of corresponding equal spaces as contained in one quarter of the profiles. Projections from the pipe sections are then drawn to the corresponding lines in the pattern.

The allowances for laps and spacing of rivet holes were not taken into consideration in these problems, as these will be governed according to the requirements and thickness of material.

Fig. 2 is a modification of the work shown in Fig. 1, and the same method of development is applicable for its solution.

It is the best practice to use the parallel or radial method in all construction drawing if the conditions and the problems permit. There are also "rules of thumb" which are close approximates and answer the purpose just as well as the theoretical method in same constructions. These, however, are simply modifications of the parallel method and require careful attention in their application.

Fig. 3 brings out very clearly the principles used in developing regular surfaces by orthographic projection (parallel method). This character of work may be very well understood by the average and advanced layer outs, but we know from experience that many of the apprentice boiler makers know little or nothing in laying out along this line, and since this subject is the basis of the layer-outs' profession it is obvious that simple problems should be treated in detail for their information. Everyday examples explained in a simple way would be of interest to the young men of the trade, where the more complicated ones would effectually scare them from any attempts to study the underlying principles.

In view of the above the writer sincerely recommends for the benefit of those who have to overcome difficulties without the aid of an early education that work for their understanding and aid be installed from time to time in THE BOILER MAKER.

A NEW TYPE OF WATERTUBE BOILER.

There are certain disadvantages in the common type of watertube boiler with horizontal or slightly inclined tubes. For the most part the water legs have large, flat surfaces, which must be stiffened by stay-bolts, and these headers frequently give trouble and are expensive to manufacture. The large number of openings in the headers, which have to be closed by hand-hole cover plates, make an excessive number of joints to be kept tight. The lower tubes are exposed to a greater degree of heat and, therefore, expand much more than the upper tubes, resulting in a higher strain in the lower tubes, causing them to bend and frequently to leak. The removal of the deposit of soot and ashes from the heating surface of such boilers is sometimes difficult, and cleaning the boiler takes time on account of the large number of joints to be remade. The circulation of the water and of the steam bubbles in the horizontal tubes is liable to be imperfect. In fact, engineers are somewhat doubtful as to the real manner in which circulation takes place in such a boiler.

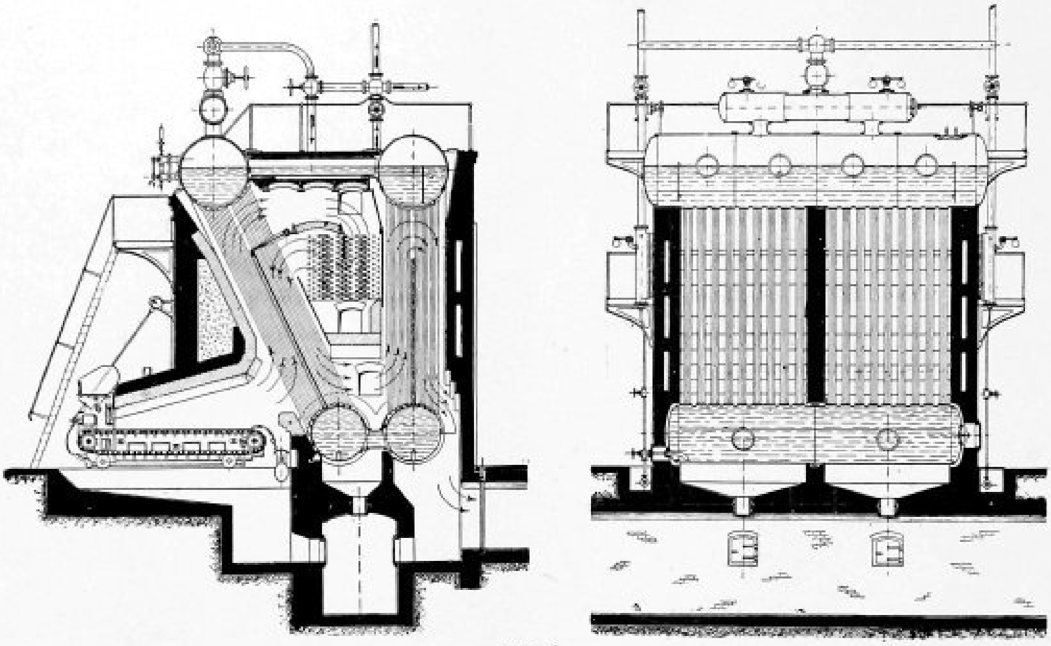


FIG. 1.

These disadvantages have led to the building of watertube boilers consisting of upper and lower drums, which are connected by vertical tubes, and two methods have been adopted in building such boilers. Some boiler makers take cylindrical drums, with the axis lying horizontal, and connect them by means of tubes. Nearly all the tubes in such case, however, and especially the outer ones, have to be given considerable curvature in order to insert them into the walls of the drum at right angles. It is difficult to inspect such curved tubes, and it is also difficult to clean them. This, together with unequal expansion, frequently causes leakage of tubes installed in this way.

Another method pursued by quite a number of manufacturers is to build the upper and lower drums with straight walls and connect them by straight vertical tubes. Straight walls in any boiler have the disadvantage that they cannot be used for any large pressure without being stiffened. Also such a boiler cannot be built for any larger capacity. The exchanging of damaged tubes in these boilers is usually very difficult.

Another method of building boilers of this type has been called to our attention by H. F. Hoevel, 50 Church street, New York City. Upper and lower drums and straight vertical tubes are used in this boiler, but the parts of the drums form-

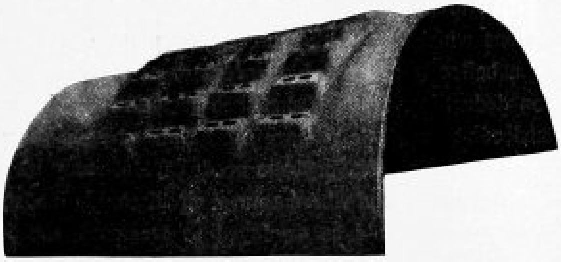


FIG. 2.

ing the tube sheets are made with pressed wave-formed sheets, as shown in Fig. 2. This is known as the Garbe patent plate, and it is claimed offers the greatest safety, since all parts of the boiler are cylindrical and special stiffness is obtained by the "stair-like" buckles in the tube plates. Fig. 1 shows an installation of the Garbe boiler, in which both straight and inclined tubes are used. The illustration also shows how automatic firing and superheating can be employed in connection with this boiler. Besides being easy to build and of strong

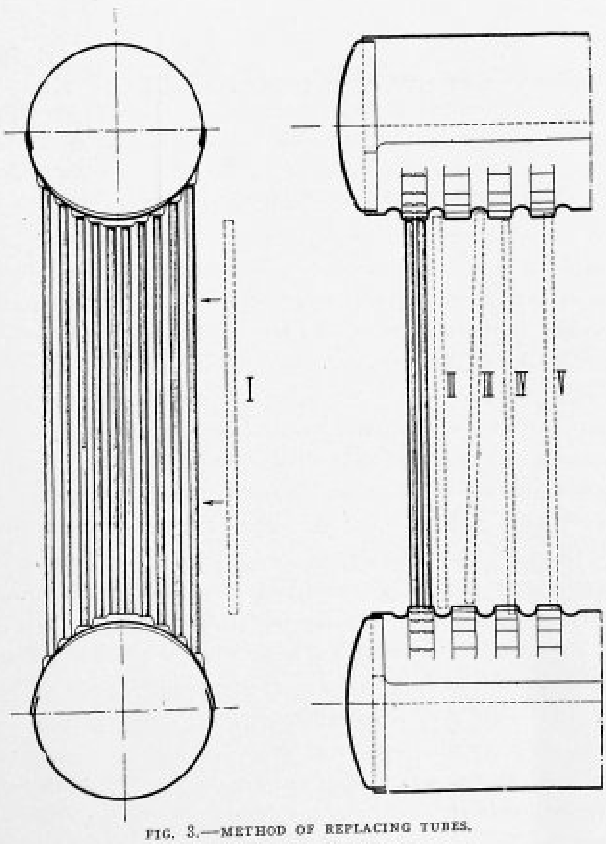


FIG. 3.—METHOD OF REPLACING TUBES.

and safe construction, the boiler can be installed in the minimum of floor space; its circulation is claimed to be very good; and since the water in the boiler is divided into comparatively small volume in the tubes, each of which is exposed to high temperature, the boiler has exceptional steaming capacity. It is apparent that the design of the boiler is well adapted for disposing of soot and ashes, and also for getting rid of scale or sediment within the boiler in any form, although the rapid circulation is claimed to keep the inside of the boiler exceptionally clean.

Special care has been taken for an easy mounting and exchanging of all parts. The tubes are arranged in parallel lines between which wave-formed grooves are arranged. This device makes it possible to put in the tubes when mounting the boiler or when exchanging damaged tubes without requiring any special openings in the boiler. The distance between the drums does not need to be changed at all, the buckles of the upper and lower drum are arranged directly opposite each other. Fig. 3 shows how the tubes are put in.

I. Inserting of the tube from the side.

II. Tube is held in the grooves.

III. Tube is raised in the groove of the upper drum and the lower end is brought before the hole of the lower drum.

IV. Tube is pushed through the hole of the lower drum, and the upper end is brought before the hole on the upper drum.

V. Tube is ready for expanding into the seats.

A damaged tube may be exchanged by forcing it into the lower drum, by bending it sideways into the groove and by simply pulling it out. It is not necessary, as with watertube boilers with horizontal tubes, to pull the whole tube through the tube hole.

From the foregoing it is evident that any unskilled workman can easily exchange a tube in the Garbe boiler, and as these are the only parts of the boiler which have to be renewed it is evident that the maintenance of the boiler is extremely simple.

This type of boiler is manufactured extensively in Europe, and can be built in any contract shop possessing the rights to use the patent Garbe plates.

TUBE RUPTURE DUE TO POOR WELDING.

A watertube boiler furnishing steam for a mill engine at the works of John I. Parkes, Ltd., Smethwick, England, exploded a few months ago and resulted in badly scalding the fireman.

The boiler was of the Stirling type, containing four drums—three upper and one lower—each 3 feet 6 inches in diameter and 10 feet long; the upper drums being connected to the lower by lap-welded, wrought-iron tubes, 3½ inches external diameter and about 15 feet in length.

It appears to have been built in 1896, and was designed for a working pressure of 150 pounds per square inch, although at the time of the accident it was under only 100 pounds. At the time of erection it had been tested under a hydraulic pressure of 270 pounds per square inch, and again in 1905 at 225 pounds. Furthermore, during the process of manufacture the tubes had been subjected to a hydraulic pressure of 1,000 pounds per square inch, both before and after bending.

The explosion was due to the failure of one of the tubes in the third row. Through the opening thus formed the steam escaped into the furnace and blew through the furnace door, seriously injuring the fireman, who at the time happened to be standing opposite.

A thorough investigation into the cause of the failure revealed the fact that it was due to a defective weld in the tube. Only on the inside edge where the fracture occurred had the iron been welded, the material over the remaining portion of the lap, which was about ½ inch wide, being merely pressed together.

Having regard to the defective manner in which the tube had been welded, it is somewhat surprising that it did not fail sooner; and no doubt had the boiler been tested occasionally to a suitable hydraulic pressure the condition of the tube would have been revealed.—*Power and the Engineer.*

The Boiler Maker

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NOTICE TO ADVERTISERS.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

Circulation of Water in Steam Boilers.

As a rule only from 60 to 80 percent of the heat contained in the fuel is absorbed by the water in a steam boiler, from 20 to 40 percent is lost. Part of this loss occurs in the furnace and part in the boiler itself. The flue gases alone carry off at least 15 percent and usually more of the calorific value of the fuel. Various conditions affect the efficiency with which the fuel can be burned in the furnace, and these conditions vary from day to day; thus a large number of factors are introduced which make the problem of improving boiler efficiency one of great complexity. In the boiler itself, however, there is probably no factor which is more important in its effect upon efficiency than the circulation of the water.

The circulation of the water in the boiler has a direct bearing upon the transmission of heat from the hot gases to the water and, consequently, it has a direct bearing upon the evaporative power of the boiler. It also has some effect upon the life and safety of the boiler. Other things being equal, the rate of evaporation, or rather the rate of transmission of heat from the hot gases to the water in the boiler, depends not so much upon how fast the heating surfaces can absorb the heat from the hot gases as upon how fast the water can absorb the heat from the heating surface. It is evident that for the benefit of the latter a good circulation of water must be maintained. Recent experiments seem to show that large heating surfaces are no longer necessary or even desirable in boilers provided the heating surface can be utilized to the best advantage. In general, the smaller the heating surface (if there is adequate circulation of water in the boiler), the more equal the expansion of the various parts of the boiler, and this is a very important point in such boilers, for instance, as the Scotch marine type.

Just how circulation takes place in various types of boilers, and particularly in watertube boilers, is somewhat difficult to explain. Glass models of boilers are frequently used to observe the direction and rapidity of flow of the water in the boiler, but these models are usually operated at atmospheric pressure, with no attempt to reduce radiation and under conditions which are vastly different from those which exist when a boiler is under a high pressure of steam. For this reason deductions drawn from such experiments are apt to be misleading and little reliance can be placed upon them for exact information. The problem needs careful study by practical boiler makers and where natural circulation is inadequate artificial means should be employed to accelerate the circulation.

An Important Test.

The low-water test of a Jacobs-Shupert locomotive firebox, which is described elsewhere in this issue, is of unusual importance, since so many explosions of locomotive boilers are ascribed to low water. From statistics furnished by the railroad companies and the Inter-State Commerce Commission, it is claimed that 98.3 percent of the explosions of locomotive boilers have been due to accidents caused by low water. As we have previously pointed out, this statement is not conclusive, and there is reason to doubt that such a large percentage of locomotive boiler explosions is due entirely to low water. However that may be, there is no doubt of the effect of low water on a locomotive firebox as ordinarily constructed with flat plates stayed by screw stays. Even if the staybolts are sound there are far too many cases of poor application of staybolts, where either the threads on the bolts themselves or those in the sheet are in poor condition and the holding power of the bolt is considerably reduced. It is not by any means easy to determine just how well a staybolt is set in the sheet, but there is usually a sufficient margin of strength so that the staybolt will not pull out of the sheet under ordinary conditions. When, however, the engineer allows the water to get low, and the crown sheet becomes red hot, the holding power of the stays decreases rapidly, sometimes as much as 75 percent, and if the water remains below the level of the crown sheet, the ends of the staybolts will be burned off. Under such conditions, the crown sheet will in most cases come down and cause a disastrous explosion.

The construction of the Jacobs-Shupert firebox, on the other hand, is such that the connection between the firebox and the outer shell is not affected so readily by overheating. The wing plates, which form the stays for the firebox, are joined to the sections of the firebox in such a manner that the riveted joints are partly protected from the fire, and, furthermore, since the box is built in flanged sections it is better fitted to resist the stresses to which it is subjected. This construction, therefore, seems to be far safer than the ordinary type of firebox where low water is likely to occur, and its use should materially reduce the number of boiler explosions due to that cause.

COMMUNICATIONS.

Less Noise in a Boiler Shop.

EDITOR THE BOILER MAKER:

The writer has visited many boiler shops in the States and Canada during the last few years, and in the course of his travels has often wondered why a "flue welder" is set up inside the shop, many times directly in the center, where everyone in the shop gets the full benefit of the air blast. This blast has got on my nerves many times good and plenty, and many men have remarked to the writer that this same air blast has bothered them so that at times they would be obliged to leave the shop for the time being.

Of course, no one expects to find a boiler shop as silent as a graveyard, but why can't the noise be cut to a minimum? Why can't the flue welder be put in one corner of the shop and enclosed or, better still, in a small building outside of the shop? Will some one kindly explain? D. N. H.

Stetes and Cities that Have Boiler Inspection Laws.

EDITOR THE BOILER MAKER:

In the November issue of the paper, page 321, reference is made to obtaining the names of the various States and cities of the United States in which license laws are in operation concerning steam boilers. The following list may be of interest in this connection:

States—Massachusetts, Minnesota, Montana, Ohio, Pennsylvania and Tennessee.

Cities—Baltimore, Md.; Buffalo, N. Y.; Chicago, Ill.; Denver, Col.; Detroit, Mich.; Goshen, Ind.; Jersey City, N. J.; Kansas City, Mo.; Lincoln, Neb.; Los Angeles, Cal.; Memphis, Tenn.; Mobile, Ala.; New Haven, Conn.; New York City, N. Y.; Niagara Falls, N. Y.; Omaha, Neb.; Peoria, Ill.; Philadelphia, Pa.; Rochester, N. Y.; Santa Barbara, Cal.; St. Joseph, Mo.; St. Louis, Mo.; Sioux City, Ia.; Spokane, Wash.; Tacoma, Wash.; Terre Haute, Ind.; Yonkers, N. Y.; Fulton County, Ga.; District of Columbia; Allegheny, Pa.; Scranton, Pa.; Pittsburg, Pa.; Hoboken, N. J.; Atlanta, Ga.; Huntington, W. Va.; Saginaw, Mich. CHARLES J. MASON.

Scranton, Pa.

A Question of Efficiency.

EDITOR THE BOILER MAKER:

In regard to the placing of braces in the outer row of rivets in a butt strap joined as described on page 335 of your November issue, I fully agree with the inspector that it materially reduces the efficiency of the joint.

The brace should be located in any of the following ways: First, so that it takes in two rivets in double shear; second, placed outside of the inside strap, and third, use a longer brace and carry it back on the middle course.

The first two methods would not give a straight pull, but the angle would be so slight that it would be immaterial.

Boston, Mass. FRANK T. SAXE.

EDITOR THE BOILER MAKER:

In the November edition of THE BOILER MAKER I notice the letter from "Foreman Boiler Shop" in the West *re* question of efficiency. I myself have acted in the capacity of foreman, and am at present superintendent of a boiler shop where we are building about 600 horizontal boilers of various sizes yearly. I have used the same construction, as shown in your letter, where stays happen to fall on a butt strap, and had no kick coming and no bad results from same.

But I quite agree with the correspondent's opinion that the ruling of the inspector is correct theoretically, since a chain is no stronger than its weakest link. But for argument's sake, which was the weakest link—the shell or the brace? Or, in other words, what was the necessity of the two rivets in the brace? I have always contended that a brace made with the palm containing two rivets—one behind the other—is not good practice, as when figuring on the strength of the stay and shear of rivets it is taken that the body of the stay should be strong enough for the pressure required for a certain amount of square inches supported, and the palm at the first rivet should have area enough each side of the rivet hole to equal the body of the stay. If that is so then the shear comes on the first rivet only, the back rivet practically doing nothing and acting merely as an ornament. Therefore, in a case where a brace comes in a butt strap, as shown, could the palm not be made heavier and only one rivet put in the palm, using a larger rivet?

I think the present style of palms in braces is not correct, but still have had no bad results. How many inspectors or boiler makers have seen the palm of a brace give way at the back rivet or palm, or ever saw the back rivet shear and the front rivet not shear, and how many have they seen where both rivet and brace break and shear at the first rivet, leaving part of the palm and the back rivet still in place? More, I should say, than the other, showing that the first rivet and palm have all the work—not the last rivet and palm. My idea of a brace is to have the shear equally on both rivets and palms. But so long as the present use of palm is accepted by our boiler inspectors no changes will be made.

I should like to hear something on this question from some practical boiler makers and not theoretical boiler men, but men who have given their life and time to practical boiler making.

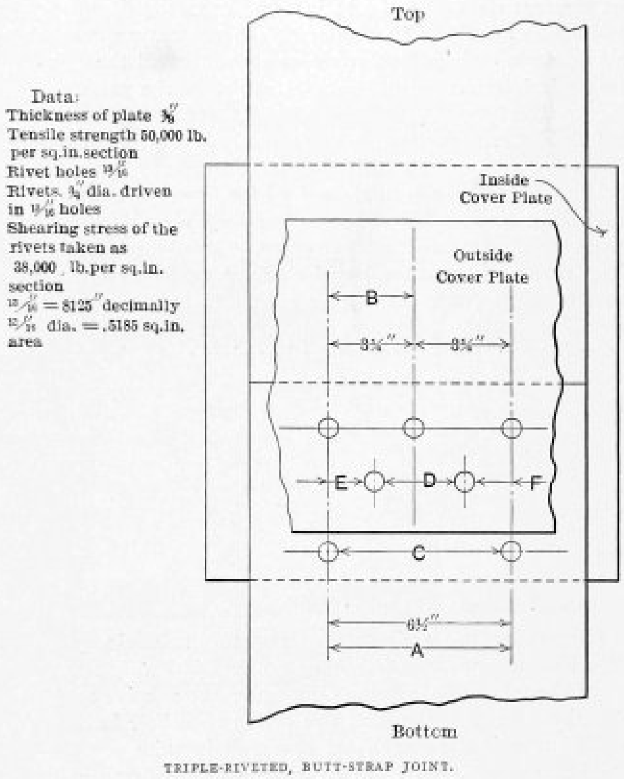
BRACE CRANK.

EDITOR THE BOILER MAKER:

Concerning the article "A Question of Efficiency," page 335, November issue of the paper, there is hardly any doubt as to the truth of the inspector's statement relative to the reduced efficiency of the joint due to the rivet hole having been drilled to suit the stays. Of course it is quite possible that no harm would ever happen to the boiler because of the brace being attached in that way, as stated by the foreman in the story, but it is true that that particular strip of joint is of lower efficiency than the remainder of the joint, and as nothing is really any stronger than its weakest part, the joint as a whole is materially weakened because of those extra rivet holes. To some of the younger readers it may perhaps not be quite clear as to how the strength of the joint has been impaired and what relation exists between the different parts of such a joint, so I am sending the following explanation which should make clear all about the strength of a joint of that type.

This is given for the purpose of showing why in triple riveted joints in boiler work the net section of the plate at the outer row of rivets (where there is only one rivet in any given section which is to be considered) is taken and used in the calculation, instead of taking the net section of the plate at the inner rows of rivets, where there are two rivets in any given strip of plate considered. In order to show this, refer to the accompanying illustration, which contains all the data that are necessary to use in the operation of finding just which is the stronger, the net section at the outer row of rivets or the net section at the inner row of rivets when the joint as a whole is considered. The plate is ⅜ inch thick;

this expressed decimally is .375 inch and is assumed to have a tensile strength of 50,000 pounds. The width of the strip which we are to consider is 6.5 inches. Now, the sectional area of this strip will be thickness times width, or expressed in figures, $.375 \times 6.5 = 2.4375$ square inches, sectional area, and $2.4375 \times 50{,}000 = 121{,}875$ pounds, which is the strength of the solid strip which we are considering. Now, let us see what the strength of the net section of the plate is at the outer row of rivets. The diameter of the rivet hole is to be subtracted from the width of the plate; for by referring to the figure it will be seen that the strip contains one-half a rivet at each side, which, of course, is equivalent to one whole rivet in the calculation. Therefore, $6.5 - .8125$ (13/16-inch = .8125 inch). This leaves a remainder of 5.6875 inches width of the net section of the strip. $5.6875 \times .375 = 2.1328$ square



TRIPLE-RIVETED, BUTT-STRAP JOINT.

inches as the sectional area of the strip, and $2.1328 \times 50{,}000 = 106.640$ pounds. This is the strength of net section of the strip at the outer row of rivets.

Now, if the plate should break, that is, pull asunder at the line of the outer row of rivets—that which we have just been considering—the only resistance to breaking is the amount of metal in the r.et section of the plate, as shown at the letter *C*. This we have shown to be equal to 5.6875 inches in width. But should the plate break along the net inner row of rivets, the resistance offered is the strength of the sections of plate *E*, *D* and *F*; and as well as this, the resistance to shearing offered by one-half of each of the rivets in the outer row, which, of course, in calculations is equivalent to one rivet. Right here we would say that this is the important point upon which this problem hinges, so to speak; that is, the strength which this rivet in the outer row affords or lends to the net section of the plate at the inner row, which a little thought should make clear to the reader. If the plate breaks along the line of the middle row of rivets and does not break at the bottom row, or outer row, as we have been calling it, it must shear off the equivalent of one rivet.

First, let us see what the plate resistance is. By measurement it will be $6.5 - (2 \times .8125) = 4.875$. Now, we are considering the two rivet holes which are to be subtracted from the width of the strip in order to find the net section of the plate at that particular place. The sectional area will therefore be $4.875 \times .375 = 1.828 +$ square inches, area of the section of plate resisting being torn asunder, and $1.828 \times 50{,}000 = 91{,}400$ pounds resistance. So much for the plate. To this resistance must be added the resistance offered by the two half rivets in the outer row. This, as we said before, is equal to one rivet. The area of a 13/16-inch driven rivet is .5185 square inch, and as the shearing stress is taken as 38,000 pounds per square inch section, we have $.5185 \times 38{,}000 = 19{,}703$ pounds. This added to 91,400, before obtained for the plate, equals $91{,}400 + 19{,}703 = 111{,}103$ pounds, total resistance to the plate breaking at the middle row of rivets, as against the 106,640 pounds resistance to the plate breaking at the bottom or outer row of rivets. Therefore, the latter is the weaker of the two, and there is where the break will occur, if at all, all else being equal. Thus, it can be seen why the net section of the plate at the outer row of rivets is taken in joints of this kind instead of the net section of the plate at the inner row of rivets. Most people think that the inner row should be taken and wonder why it is that the outer row is taken, and only one rivet hole subtracted from the full width of the strip. Most every one thinks that the two rivet holes should be subtracted from the full width of the strip. As far as the plate itself is concerned, of course, it is weaker where the two rivet holes are. When taken into consideration with the fact that there is one rivet which must be sheared off if the plate is to break along the line of the inner row of rivets, the resistance to this rivet shearing off, of course, aids the net section of the plate at the inner row of rivets. A little deep thinking on the preceding paragraphs should make clear the entire subject to the reader.

There are four rivets in double shear and one rivet in single shear in the strip which we have been considering. The resistance to the shearing of one rivet in single shear was shown to be 19,703 pounds. The resistance to shearing of each of the rivets in double shear will be: rivets in double shear are stronger than those in single shear by 85 per cent. So that, as 38,000 pounds is the stress taken for single shear, $38{,}000 \times .85 = 32{,}300$ pounds and $38{,}000 + 32{,}300 = 70{,}300$ pounds, to be taken as the shearing stress for the four rivets.

The area of each rivet is as before shown, .5185 square inch, and $.5185 \times 70{,}300 = 36450.5$ pounds, resistance offered to the rivets being sheared; this multiplied by 4 gives 145,802 pounds. To this add 19,703 pounds (for the one rivet in single shear), and we have a total of 165,505 pounds. The net section of the plate is, therefore, the weaker, namely, 106,640 pounds, and the efficiency of the joint as a whole becomes $\frac{106{,}640.625}{121{,}875} = 87.5$ percent. It will be remembered that the 106,640.625 pounds refers to the net section of the strip, while the 121,875 pounds refers to the solid strip.

The foregoing requires careful study and deep thought, and if this be given no further difficulty should be experienced with the phases of the problem which we have been considering.

Charles J. Mason.

Scranton, Pa.

How to Bend Angle-Iron Rings.

Editor The Boiler Maker:

Referring to the inquiry published in your October issue for a method of bending angle-iron rings on a sectional flanger, the following method has been used by the writer for bending some rings of very nearly the size mentioned by your cor-

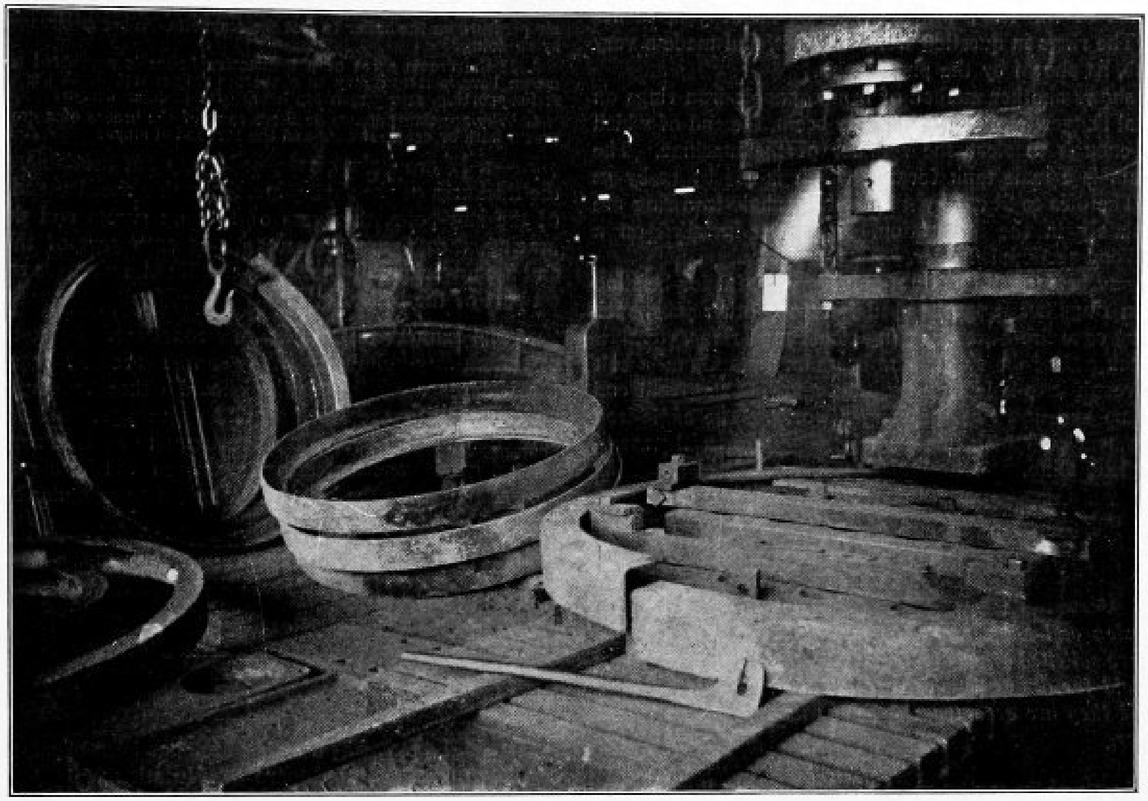


FIG. 1.—ARRANGEMENT OF DIES FOR BENDING ANGLE RINGS ON A SECTIONAL FLANGER

respondent, and the work was done on a W. H. Wood sectional flanging machine:

I made a die 10 inches high with a 34-inch radius with the edge turned for 4 inches to a 11/16 inch depth to suit the web of the angle-iron. The upper ram was brought to bear on the dies with a 1/16-inch clearance, so that the iron could move more easily around the die.

The horizontal ram is fitted with a plain die to suit the out-

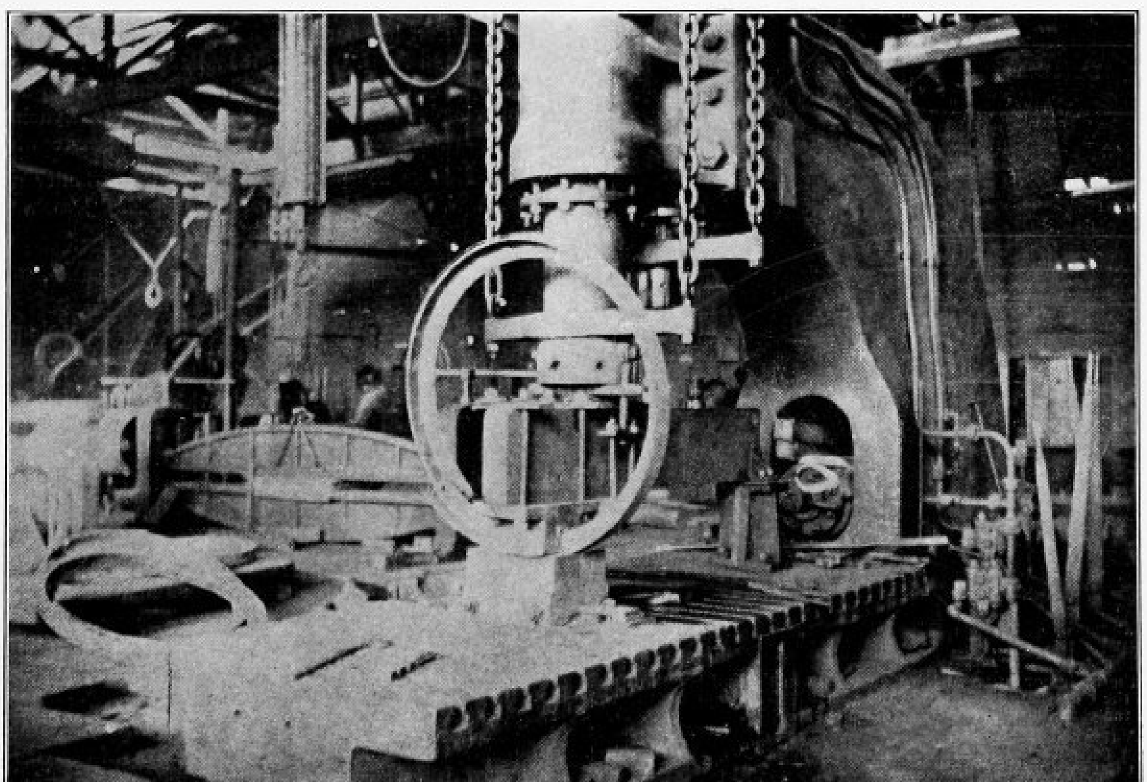


FIG. 2.—SWAY BEAM METHOD OF BENDING ANGLE RINGS ON A SECTIONAL FLANGER.

side radius of the ring, which would be about $34\frac{3}{4}$ inches radius. The rings in question were bent hot, and made a very pretty job, as shown by the photograph.

Fig. 2 shows another method of bending angle-iron rings on a sectional flanger by means of a sway beam, the end of which projects enough to clear the cylinder of the machine. The sway beam is a male tank former, which is $4\frac{1}{2}$ by 12 by 52 inches. The dies to fit a 3 by 3 by 40-inch angle-iron ring are shown plainly in the illustration, Fig. 2, as installed on a W. H. Wood sectional flanger.

This sway beam method is not only very useful for bending angle-iron rings but it can be used for many other jobs, such as bending ogee fire-boxes, riveting round mud-rings, etc.

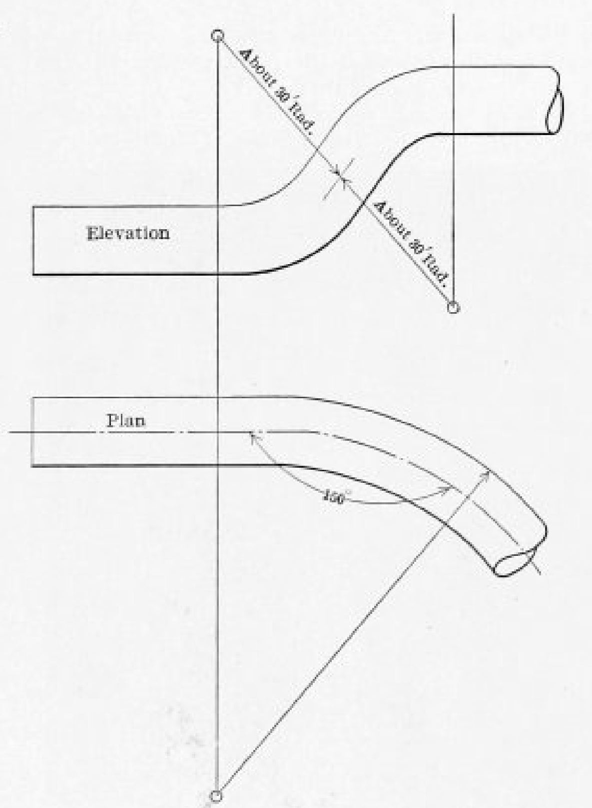
The back end of the sway beam bears on a stand and a bolt is put through it to hold it in position, allowing the front end to move up and down as the flanger works. The angle-iron rings are bent cold with this device. JOHN BUTLER.

Springfield, Ohio.

QUERIES AND ANSWERS.

Discussion and answers to the questions published in this column are solicited from our readers. All such contributions will be paid for at our regular rates when acceptable for publication if they are accompanied by the name and address of the writer.

Q.—Will some of the readers of THE BOILER MAKER tell me through your valuable paper how to develop the angles in a pipe having a compound curve, there being two radii in the elevation and another radius in



the plan, the radius or curve in the plan taking in the full length of two curves in the elevation, as shown in the sketch? The radii for the two curves in the elevation may be equal or unequal. O. M.

Q.—1. A railroad receives a second-hand locomotive, but does not know what steam pressure the boiler will carry. What is the proper method to find out the safe working pressure?

2. What is the best method to test staybolts to find if they are broken. Should the boiler be empty or have a steam pressure to get the best results from a hammer test? I understand that on some roads they put an air pressure on the boiler to test the staybolts. What advantage is gained by so doing?

3. If the crown sheet of a locomotive boiler is supported entirely by crown bars, is it necessary to brace the wagon top, or is the wagon top self-supporting, said wagon top being of a circular design?

4. Why are the first two or three rows of the braces of a crown sheet, crown bars or crown braces and the rest radial stays? A READER.

A.—1. If drawings of the boiler are not available, measure the thickness of the shell plate, determine the size and spacing of the stay-bolts, thickness of fire-box sheets and details of bracing, then figure the strength of each part of the boiler, and use a working pressure which will not overstress the weakest part of the boiler.

2. The hammer test is generally considered the best method of testing stay-bolts unless they can be carefully examined in the water space. The boiler should either be empty or be under hydraulic pressure, not under steam pressure; air pressure could also be used, but there seems to be little need for it, since a good inspector can tell a broken bolt by tapping it on the fire side while the boiler is either empty or under hydraulic pressure.

3. It is not necessary to brace the wagon top.

4. In order to provide greater flexibility to accommodate the expansion of the flue sheet.

PERSONAL.

WM. H. BRYAN, of St. Louis, Mo., has been appointed chief engineer of the Chicago Board of Education.

A. ANDERSON, who was for several years with the Mexican National Railway at San Luis Potosi, Mexico, and has lately been connected with the Santa Fe Railroad at Topeka, Kan., has returned to Mexico, and is now traveling boiler inspector of the National Lines of Mexico.

J. R. HAZELHURST, after an absence of three and one-half years, has returned to the Lackawanna Steel Company, Buffalo, N. Y., and has taken his former position as layer-out.

E. J. LYNCH has opened a boiler shop, with works at Lindsey street and A. B. & A. R. R., Atlanta, Ga., under the name of E. J. Lynch & Company, and is prepared to do all classes of boiler making and steel plate working. Mr. Lynch has had fifteen years' experience in this line and guarantees his work.

J. A. HOLDER has been appointed foreman boiler maker of the S. A. G. Railway at Atlanta, Ga., vice E. J. Lynch, resigned.

TECHNICAL PUBLICATIONS.

Proceedings of the Western Railway Club. Volume XXII. Size, 6 by 9 inches. Pages, 391. Numerous illustrations. Chicago, 1910: The Western Railway Club.

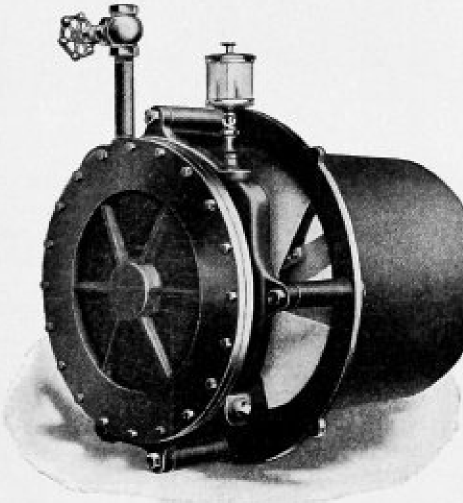
Most railway men are familiar with the scope and activities of the Western Railway Club. It is an organization which meets the third Tuesday of each month, except during June, July and August, and each meeting is taken up with the discussion of carefully-prepared papers on important railway subjects. The present volume contains not only all the papers which have been read before the society, but also the complete discussion of these papers and various matters relating to the administration of the club affairs. The principal papers in this volume, which comprises the proceedings for 1909-1910, are as follows: Railways and Railway Devices; Twentieth Century Inspection, or Run, Repair or Transfer; Transportation of Explosives; Electrification of Railways; Brake Manipulation; The Unit System; Development of the Gas Engine; Rules of Interchange; Graphical Study of Information and Locomotive Headlights.

ENGINEERING SPECIALTIES.

Turbo-Undergrate Blower.

The B. F. Sturtevant Company, Hyde Park, Mass., have recently placed upon the market a turbo-undergrate blower that consists of a single-stage impulse steam turbine direct connected to a propeller type fan.

The bucket wheel of the turbine is a solid steel forging carefully machined, the steam buckets being milled on the periphery of the bucket wheel. The steam nozzles are made of Tobin bronze, and are held in place by composition draw-up nuts. The construction of the steam case gives great accessibility for inserting, removing or cleaning the steam nozzles. An ample dust proof phosphor bronze bearing and thrust washers are provided with oil-cup lubrication. The construction of the bearing makes it possible to renew the bearing at a small cost.



The built-up fan is of the propeller type, and consists of six polished sheet aluminum blades rigidly fastened with hard-drawn copper rivets into a bronze hub, which is finished all over to secure the proper balance necessary for the high rotative speed of these sets. The materials used in the construction of the fan, it is claimed, insure great mechanical strength and also great corrosive resisting power. The stationary members of the blower set are constructed of cast iron parts, of ample strength and rigidity.

It is claimed that this blower is practically silent in operation, and requires a minimum amount of care and attention, as it can be controlled by a hand damper regulation or by regulating valves operated by the boiler steam pressure. The exhaust steam from the turbine contains no oil, and consequently may be used to best advantage for any work for which exhaust steam may be put, such as feed-water heating, etc., or it may be discharged into the ash pit, producing excellent results with coals that would ordinarily cause serious trouble by clinkering. The blower can be placed with equal ease in the front, side or back wall of the brickwork of the boiler setting.

The manufacturers claim that these blower sets can be applied with excellent results to power plants that fall under the following classifications:

First. Electric light and railroad power plants that need increased draft during the peak of the load.

Second. Power plants that have outgrown their stack capacity and need 25 to 50 percent increase in brake-horsepower.

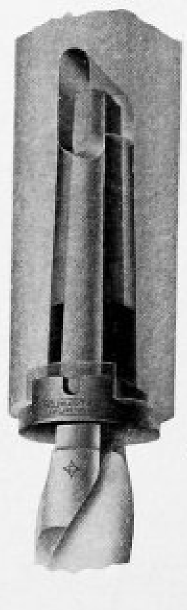
Third. In heating systems for hotels, department store, flats, schoolhouses, etc.

Fourth. In small plants that need an increase in boiler horsepower.

A New Drive for Flat Twist Drills.

The questions connected with using and driving twist drills, forged or twisted from flat bars of high-speed steel, are probably receiving more attention from mechanics at the present time than any others connected with the use of tools. Although attempts to solve the problem of drive have been numerous—complicated chucks have been designed to hold and drive the rough end of the flat bar of steel; the shank ends of the bars have been spirally twisted and machined to form taper shanks fitting regular taper sockets; more or less cumbersome taper shanks have been soldered or riveted to the shank ends of the flat twist drills—none of these methods has seemed to settle the matter beyond the possibility of further question.

The Cleveland Twist Drill Company, of Cleveland, Ohio, have recently applied for patents on a new device for driving flat, taper shanks that are tapered both on the flat sides and



round edges. These shanks are regularly furnished on this company's Paragon flat twist drills, and are driven by sleeves or sockets internally equipped with flat taper holes, accurately fitting the shanks and externally tapered to fit standard taper sockets or spindles. In the case of large diameter flat twist drills having No. 6 shanks, this drive was found to have certain disadvantages, as it made necessary the use of cumbersome extension reducing sockets to adopt the large taper shanks to the drill press spindles, which seldom have a taper hole larger than No. 6. To overcome this difficulty as well as to provide additional driving strength is the twofold object of the new device.

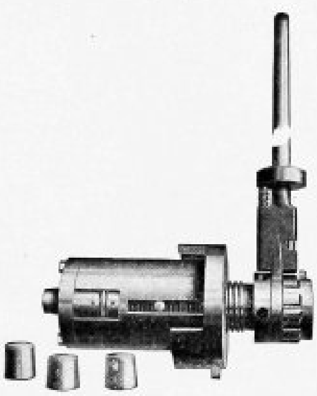
To this end both the No. 5 and No. 6 Paragon shanks have been redesigned the same length as regular taper shanks, the taper on the round edges being regular Morse taper as formerly. When, therefore, this modified shank is inserted directly in the spindle the upper end of the shank is received and driven by the driving slot in the spindle just as is the tang of an ordinary taper shank drill. This alone would constitute a strong and practical drive but for the lack of support the shank would have on its two flat sides at the lower end of the spindle. To provide against the resultant possibilities of vibration and wear between the shank and spindle, and to furnish a powerful additional drive at the lower end of the shank where its cross sectional area is greatest, a new and original type of socket, called the Paragon Collet, has been evolved.

As shown in the illustration the collet consists of two lugs projecting upward from a flattened disc through which is cut a rectangular hole to receive the Paragon shank. The lugs have rounded outside surfaces ground to standard taper and flat inner surfaces tapered to fit the flat taper shank. The groove is provided to receive the point of a drift key in case the collet should stick in the spindle. When the collet is on the shank the combination is practically an interchangeable taper shank with unusually long tang.

The additional drive is provided by means of an extension projecting (upward in the case of vertical drilling) from the circular base of the collet. This projection mortises into a slot cut across the end of the spindle conforming to the standard slots now being put in the spindles of heavy-duty drill presses by several well-known manufacturers. That this tongue-and-groove drive at the large end of the shank is very much stronger than any drive on the tang could possibly be is made evident by a single glance at the figure. The collets without this extension will fit any spindle or socket, and will be furnished to those whose spindles are not fitted with slots when this requirement is plainly specified, but they will, of course, not have the additional driving strength otherwise afforded.

A Combined Tube Cutter and Expander.

Every boiler maker knows what a laborious job it is to cut out a ruptured or burnt tube by hand. A tool is on the market, however, which may be used for cutting out tubes and also for expanding tubes. The tool can be used for cutting out a tube just inside a tube sheet or for trimming it on the outside to the proper length for beading. The tool can then be quickly changed to a roller expander and the tube expanded in

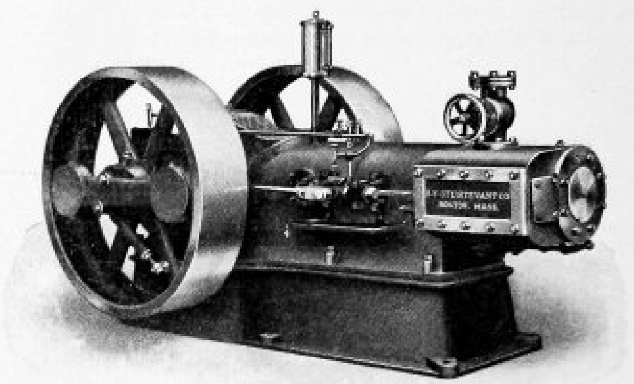


place. As shown in the illustration, it is operated by a ratchet and is equipped with a screw feed, which does away entirely with the use of a hammer.

It is also claimed that the screw feed insures an even pressure on the rolls or on the cutters, as the case may be. The rolls are made tapering so as to conform to the taper of the mandrel, the pressure thus being even across the full thickness of the tube sheet. The ratchet will work both the cutter and the expander, the shoe cutters being fitted to go in from the inside just the same as the rolls fit the pockets, where they cannot drop out. In changing the tool from a cutter to an expander, the pin in the mandrel must be taken out and replaced when changing back. This tool is manufactured by the Liberty Manufacturing Company, Pittsburg, Pa.

Sturtevant Horizontal Engines.

The engine illustrated is of the horizontal center crank type, built by the B. F. Sturtevant Company, Hyde Park, Mass. It is designed and built for both throttling and automatic regulation, and for medium, high and low-pressures. The manufacturers claim for these engines compactness, durability, quiet and satisfactory operation. The frame is equipped with openings which render the recipocating parts easy of access, yet which may be closed, oil and dust tight by covers provided for the purpose. The cylinder is thoroughly insulated and equipped with relief valves adjustable to operate at any desired pressure. A water-shed partition prevents the passage of the oil from the frame into the cylinder, and steam from the cylinder into the frame. The linings of all bearings are Sturtevant white metal, which has proven its value for



high speed work for fifty years. The main bearing combines the best points of both the two and four-part boxes, and is designed in such a manner that it is impossible for any oil to flow along the shaft. The lubrication is of the gravity type, oil supply being contained in an elevated tank of large capacity, from whence pipes convey the oil to all bearings. A Rites governor located on the fly wheel of the automatic type gives accurate speed regulation. The throttling engines may be equipped with any type of throttling governor.

The Sturtevant Company claim that in this engine they are putting the best material and workmanship obtainable, and that for all work requiring a quiet running high-speed efficient engine, for either high, medium or low pressure, this engine will meet all requirements if they are within its field.

Starrett Micrometer Depth Gage.

This gage is designed for measuring the depth of grooves, holes or irregular parts. It has a ½-inch movement of the screw reading in thousandths, and with two ½-inch and one

1-inch standard collars to slip off or on the spindle 2½-inch readings in thousandths can be obtained. The split nut is covered and protected by a patent graduated sleeve, which not only protects the nut from dirt but provides a quick and accurate way of taking up wear and adjusting the micrometer to insure correct reading. The sleeve being held by a stiff friction may be rotated by a spanner, so that the zero lines will coincide for correct reading. The head is about 3/10 inch thick. This and the point of the measuring rod are hardened. This tool is manufactured by the L. S. Starrett Company, Athol, Mass.

SELECTED BOILER PATENTS.

Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,

LOAN AND TRUST BUILDING,

Washington, D. C.

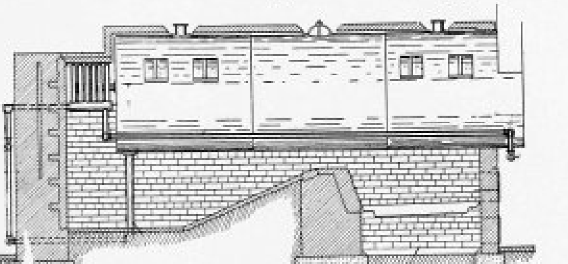
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

967,968. LOCOMOTIVE SMOKE-BOX. JAMES ALBERT PEGG, OF STRABANE, ONT., CANADA, ASSIGNOR OF ONE-HALF TO WILLIAM HENRY DAWSON, OF STRABANE, ONT., CANADA.

Claim 1.—In combination with a locomotive boiler and smoke-box, of a horizontal partition secured to the rear end of a boiler between the bottom group and the middle group of tubes, leaving a small open space between the end of the partition and the end of the smoke-box for the products of combustion to pass. Three claims.

968,023. FEED-WATER HEATER FOR BOILERS. WILLARD C. BARNES, OF SOUTH WEYMOUTH, MASS.

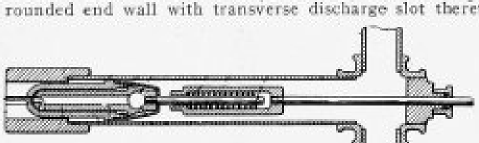
Claim 3.—The combination with a boiler setting and a boiler supported thereby to form a chamber between the rear end of the boiler and the rear and top walls of the setting, of a feed-water heater located in said chamber and connected within the setting with the boiler for the circulation of cold water therethrough, and with a supply for cold



water, a valve controlling the supply for cold water, a drainage pipe for said boiler extended through the rear wall of the setting, and a drainage pipe for the feed-water heater extended through the rear wall of the setting and connected with the drainage pipe for the boiler outside of the said rear wall. Six claims.

966,987. BLOWER FOR BOILERS. EDWARD B. BARNHILL, OF MARION, IND., ASSIGNOR TO ERNEST W. MICKLIN, OF DETROIT, MICH.

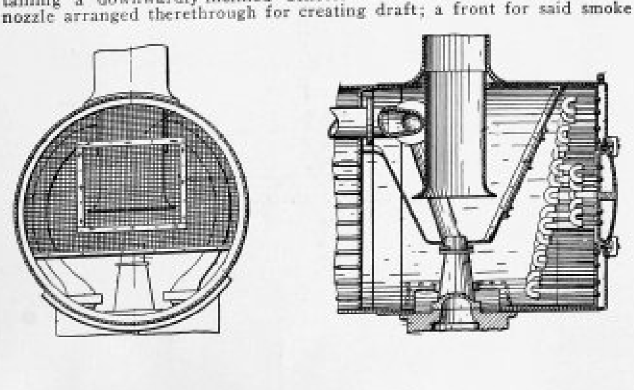
Claim 1.—In a blower for a boiler, a nozzle, a hollow tip therein having a rounded end wall with transverse discharge slot therethrough,



and a plug rotatable in the tip having a port in its end face that is adapted to cross the slot at substantially right angles in all positions of the plug. Five claims.

966,884. LOCOMOTIVE. JOHN F. BECK, OF GRAND RAPIDS, MICH., ASSIGNOR OF ONE-HALF TO HARRY VANDERVEEN, OF GRAND RAPIDS, MICH.

Claim 3.—The combination of a locomotive having a smoke box containing a downwardly-inclined deflector in front of the flues with a nozzle arranged therethrough for creating draft; a front for said smoke



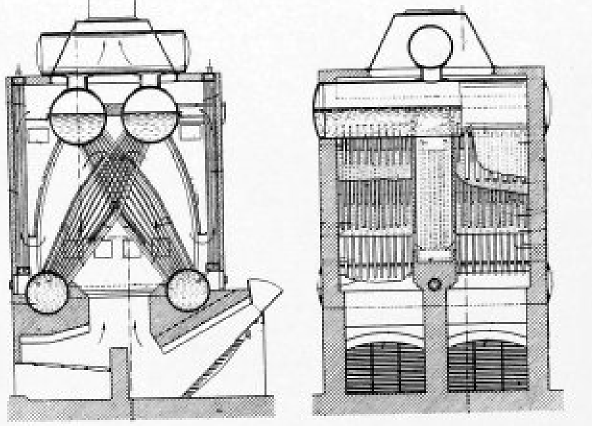
box containing a door, both double-walled to provide a water chamber therein; a feed-water supply tank; a circulating connection from said tank to the chambers of said front and door independent of said boiler conection, coacting. Nine claims.

966,601. MECHANISM FOR OPERATING FURNACE DOORS. SAMUEL D. ROSENFELT AND HENRY HELMHOLTZ, OF CHICAGO, ILL.

Claim 1.—The combination with a furnace, of fire doors pivoted at their upper extremities to swing in the same vertical plane; intermeshing gear teeth on the upper extremities of said doors; a piston cylinder, means for admission and exhaust for said cylinder; a piston rod; a link connection between said piston rod and said doors for operating the latter; a manually operated lever pivoted to said furnace; means for holding said lever in different positions; a tubular socket member pivoted to said lever; and a connecting rod slidable in said socket member and connected with said piston rod. Two claims.

967,718. WATER-TUBE STEAM GENERATOR. AUGUST GOTTLOB BURKHARDT, OF DUSSELDORF, GERMANY.

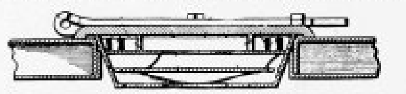
Claim 2.—In a water-tube steam generator, the combination with steam and water drums arranged in the upper part of the generator, water-drums, arranged in the lower part of the generator, banks of generating tubes crossing one another, lateral circulating tubes, both set of tubes connecting the upper and lower drums, and a furnace for generating heating gases, of baffles dividing the heating gases into two



currents which rejoin at the crossing point of said generating tubes and then separate again so as to flow down between the said circulating tubes, of baffles arranged near the outer surface of the circulating tubes and leading the heating gases, after having passed the circulating tubes, upward so as to sweep feed-water-heater tubes forming the outer walls of the heating gas flues. Two claims.

970,347. FURNACE-DOOR. GEORGE O'NEILL, OF MONCTON, NEW BRUNSWICK, CANADA.

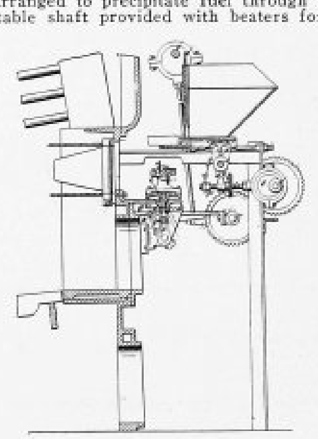
Claim 1.—A furnace door having a hollow lining member provided with a central opening, said member being formed with radial corruga-



tions around the opening adapted to direct the air toward the opening and at the same time to increase the air-heating surface. Four claims.

970,432. AUTOMATIC FUEL-FEED MECHANISM FOR FURNACES. GEORGE DINKEL, OF JERSEY CITY, N. J.

Claim 1.—In combination with a furnace having a fuel feed opening, a fuel propeller arranged to precipitate fuel through said opening, consisting of a rotatable shaft provided with beaters for impact with the



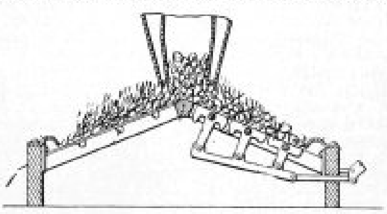
fuel, means for rotating said shaft, means for imparting to said propeller an oscillatory motion in two planes at right angles to each other, and fuel feed mechanism arranged above said propeller. Thirteen claims.

970,421. WATER-LEVEL REGULATOR. NOIBERTO GUY COPLEY, OF FOSTORIA, OHIO, ASSIGNOR TO THE "S. C." REGULATOR COMPANY, OF FOSTORIA, OHIO, A CORPORATION OF OHIO.

Claim 3.—The combination with a boiler, of pipes respectively connected with said boiler above and below the water line therein, of a generator connected with said pipes, said pipes being capable of turning on their points of attachment to the boiler so as to raise or lower the generator, means for feeding water to the boiler, and a regulator under control of said generator for regulating the supply of water to the boiler. Five claims.

968,830. GRATE. DAVID BOIES AND JOSEPH A. WADDELL, JR., OF SCRANTON, PA., ASSIGNORS TO SPENCER HEATER COMPANY, OF SCRANTON, PA.

Claim 1.—In combination with a grate comprising a plurality of bars mounted to be rocked therein, of means for actuating the same to shake the grate, said bars being each provided with depending portions of uniform dimension throughout the length of the bar, the depending por-



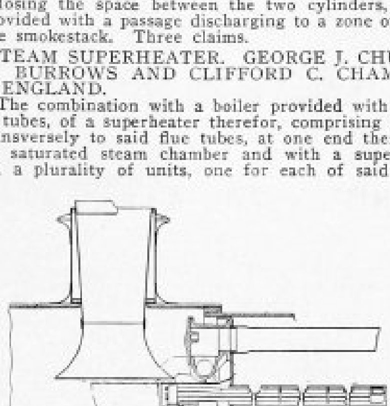
tions of the several bars being of increased dimension toward the fuel feeding point of the grate, said depending portions adapted to co-operate with the sides of the adjacent bars and effect variable openings therebetween from the fuel feeding point of the grate when the bars are actuated, and depending levers on each of said bars connected with said actuating means. Three claims.

968,882. LOCOMOTIVE SMOKESTACK. AUGUSTUS F. PRIEST, OF CHICAGO, ILL.

Claim 1.—A locomotive smokestack, comprising a lower cylinder, an upper cylinder, said cylinders being spaced apart in end relation with each other and each having an open unobstructed passage therethrough, a surrounding cinder-intercepting chamber rigidly secured to said cylinders and inclosing the space between the two cylinders, said chamber being also provided with a passage discharging to a zone of less pressure than is in the smokestack. Three claims.

969,088. STEAM SUPERHEATER. GEORGE J. CHURCHWARD, GEORGE H. BURROWS AND CLIFFORD C. CHAMPENEY, OF SWINDON, ENGLAND.

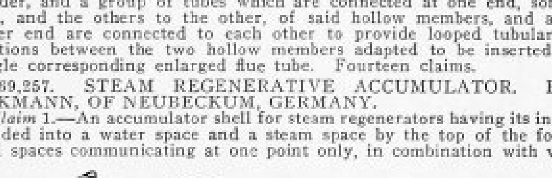
Claim 3.—The combination with a boiler provided with a plurality of enlarged flue tubes, of a superheater therefor, comprising a main header extending transversely to said flue tubes, at one end thereof, and provided with a saturated steam chamber and with a superheated steam chamber, and a plurality of units, one for each of said enlarged flue



tubes and each comprising a pair of hollow members, in communication, one with one, and the other with the other, of the chambers in said header, and a group of tubes which are connected at one end, some to one, and the others to the other, of said hollow members, and at the other end are connected to each other to provide looped tubular connections between the two hollow members adapted to be inserted in a single corresponding enlarged flue tube. Fourteen claims.

969,257. STEAM REGENERATIVE ACCUMULATOR. EMIL ECKMANN, OF NEUBECKUM, GERMANY.

Claim 1.—An accumulator shell for steam regenerators having its interior divided into a water space and a steam space by the top of the former, said spaces communicating at one point only, in combination with valves



in said top which may be opened when the pressure of the steam below them reaches a certain degree, means for supplying steam to the water compartment and means for regulating the depth below the surface of the point of such supply. Six claims.

969,294. AUTOMATIC WATER REGULATOR AND SURFACE BLOW-OFF. DANIEL M. MAXON, OF ST. LOUIS, MO.

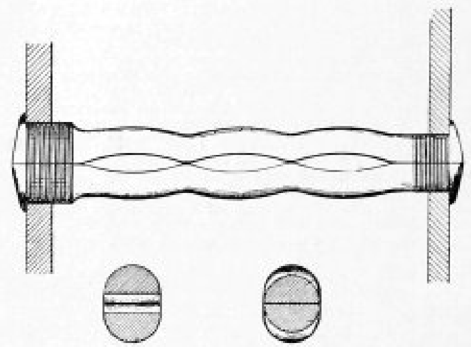
Claim.—The improved automatic water-level indicator and surface blow-off for steam-boilers, comprising a float in the form of an open pan adapted to rest upon the water in a steam boiler and rise and fall therein with the fluctuations of water-level; a blow-off valve mounted exterior of the boiler; a rod extending from said valve to said pan, so that said valve and said pan will move in unison as the water-level rises or falls; two stuffing-boxes through which the rod operates; a weighted-lever applied to said rod at a point intermediate of said two stuffing-boxes; an adjustable weight on said lever; a blow-off pipe through which water from a point near the bottom of the interior of said pan passes out of said boiler whenever the water-level rises sufficiently to overflow said pan, and through which pipe steam passes when the water-level abnormally falls; a pipe into which the discharged water and steam pass from said blow-off pipe to one side of said valve; and another pipe into which said steam and water are discharged after passing by said blow-off valve. One claim.

969,316. BLOWER FOR WATER-TUBE BOILERS. THOMAS S. WALLER AND EDWARD B. BARNHILL, OF DETROIT, MICH., ASSIGNORS TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A COPARTNERSHIP.

Claim 1.—The combination of the tubes and wall of a boiler, said wall having a recess therein opening through the inner face of the wall, of a blower comprising a header in said recess adapted to be moved toward and from said tubes, and means adapted to be closed between the header and tubes when the header is moved from the tubes into the recess. Fifteen claims.

969,383. STAY-BOLT. MYLES MAHONEY, OF MONTREAL, QUEBEC, CANADA.

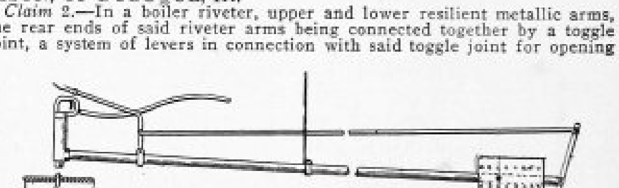
Claim 1.—In a stay-bolt, a middle length extending between suitably formed ends and separated for the greater part of its length into parts



forming spaces therebetween for the purpose of the expansion and contraction of said parts. Three claims.

969,553. BOILER-RIVETING HAMMER. ANDREW M. MORRISON, OF DUBUQUE, IA.

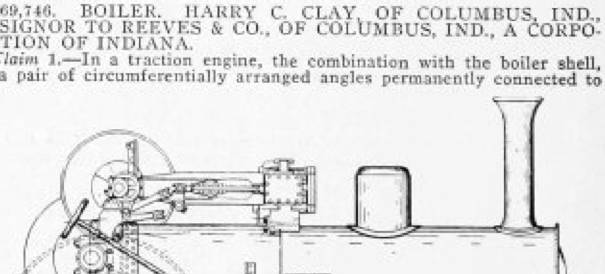
Claim 2.—In a boiler riveter, upper and lower resilient metallic arms, the rear ends of said riveter arms being connected together by a toggle joint, a system of levers in connection with said toggle joint for opening



and closing said riveter arms, opposite metallic sheets bolted together at the rear end of the device, the upper riveter arm having a hinged bolt passed therethrough and secured to said sheets for giving it a hinging action, upper and lower rivet dies secured to the forward end of said riveter arms, and means for heading rivets. Two claims.

969,746. BOILER. HARRY C. CLAY, OF COLUMBUS, IND., ASSIGNOR TO REEVES & CO., OF COLUMBUS, IND., A CORPORATION OF INDIANA.

Claim 1.—In a traction engine, the combination with the boiler shell, of a pair of circumferentially arranged angles permanently connected to



said shell, and a king-post member detachably secured to the vertical arms of both said angles. Three claims.

969,752. DEFLECTOR FOR FURNACES. MALCOLM GREEN, OF BOSTON, MASS.

Claim 1.—In a fire-box deflector, the combination of a tubular supporting girder, a saddle fitting over said girder and channeled on its upper side, mutually matching blocks of refractory material recessed to embrace the girder and fit the channeled saddle, inclosing the girder and suspended by the girder, and means to maintain cooling circulation in the tubular girder. Two claims.