The Boiler Maker

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THE BOILER MAKER

JANUARY, 1923

Heavy Plates Used in Fireless Locomotive

Details of Construction of the Tank of the Largest Fireless Steam Locomotive Ever Built

By C. E. Lester

It is thought that in describing the tank of this locomotive that a word in reference to the general description of the locomotive should be given. The designers' reference gives, perhaps, the most clear and concise, short description and is quoted verbatim. "The fireless steam locomotive is a steam locomotive without boiler and firebox. In place of a boiler the fireless locomotive carries a tank containing water which is heated from a suitable stationary boiler or boilers. To insure dry steam the storage tank is filled but four-fifths with water. The locomotive tank is specially lagged and jacketed to prevent loss of heat.

"As steam is used by the locomotive the temperature of the water and the pressure of the steam in the tank is gradually reduced and part of the water turns to steam."

The locomotive is suitable for a wide range of shifting and hauling within reasonable limits as to distance. Due to its fireless features the locomotive is especially valuable around woodworking plants of all kinds, textile mills, powder works and other ammunition plants, oil works and innumerable places where fire locomotives would be dangerous. The steam is generated in the stationary plant more economically than in a locomotive.

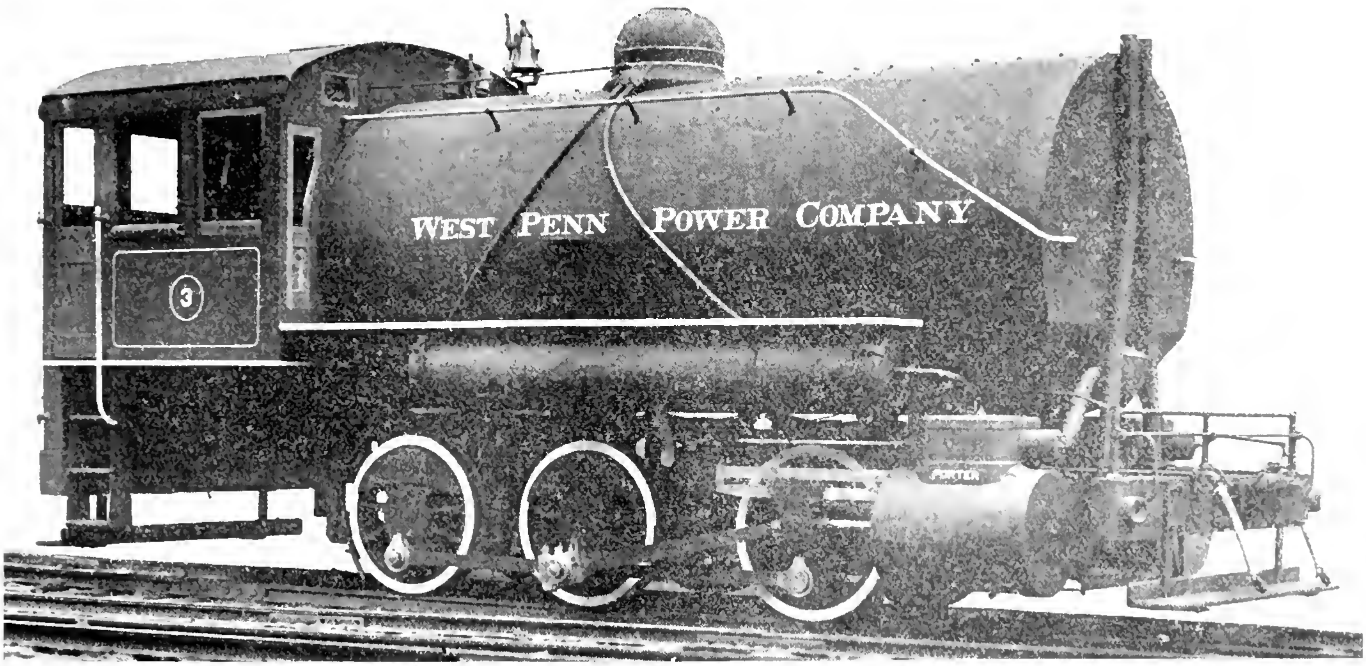
To charge the tank it is first filled four-fifths full of water and the steam from the stationary plant turned in. As soon as the steam equalizes in temperature and pressure the charge is completed and the steam is shut off. The charging fittings are then disconnected and the locomotive is ready for work.

For storing steam there must be water in the tank. Filling the tank with steam without water is useless. The stored energy is the heat in the hot water which turns the hot water into steam as fast as the steam is used. The hot water will continue to turn into steam at gradually reducing pressures until it reaches atmospheric pressure and 212 degrees F. A tank of hot water will supply about fifteen times as much steam as will fill the same tank.

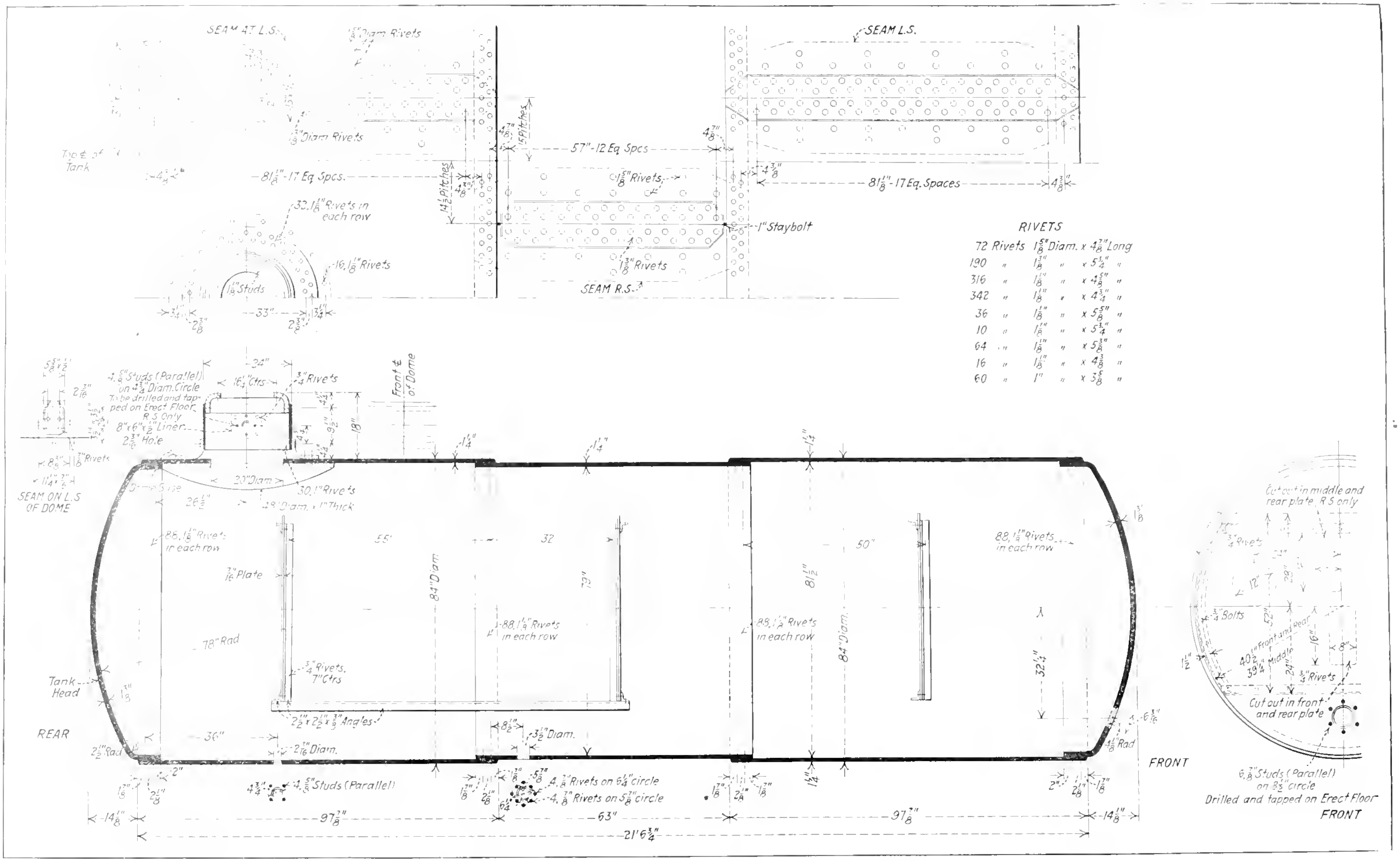
Details of Construction

The construction of the tank was of considerable interest due to the unusually heavy plate and large rivets used; it being, in fact, much heavier and larger than anything ever before attempted in the shop where constructed. The shop contains both a Southwark sectional flanging press and a Chambersburg four post flanger, but they were both of too small range to handle the heads, which were dished and spun by the Midvale Ordnance Company.

The type of power rolls in the shop could not handle the welt straps without a flat section, due to the distance between



Large Capacity Fireless Locomotive for Industrial Service



Details of Tank for Fireless Locomotives and Arrangement of Longitudinal Seams, Rivet Sizes, Layout of Heads, Dome and Tank Sections the rolls, so it was found necessary to press them under the four post press. This was done by means of a long cast iron V block for a matrix and a wooden former. The dome base and ring were also formed on the four post press by use of a former and matrix which were part of the regular shop equipment, the products being used on many of the larger types of locomotives built in the plant.

The two shell plates 1¼ inches by 98½ inches by 261 inches and 1¼ inches by 63½ inches by 252½ inches were too large to handle in the plate planer and due to the plates all being about ½ inch over size it was found necessary to chip all calking surfaces and butt joints. This was extraordinary only in that to chip 130 feet of 1¼-inch plate entails quite some labor. The large diameter of the shell courses precluded the possibility of getting them under any drill press in the entire plant so it was necessary to lay out all plates for drilling on the flat; that is to say, all holes in the shell were drilled before rolling. For the purpose of fitting up, the heads had 24 holes in groups of three drilled equally distant on the circumference. These were drilled ¼ inch smaller than the finished size of the holes. Due to the necessity of drilling plates before rolling, unusual accuracy was necessary, especially in view of the fact that there were variations in thickness in different sections of the plate as high as 0.005 inch.

DRILLING THE SEAM HOLES

Before bending the plates, all the longitudinal seam holes were drilled ⅛ inch small to compensate for errors and irregularities. The circumferential holes were drilled full size in the plates. On the assembly, after fitting the shells to the heads with ⅞-inch tack bolts in the tack holes, drilling was commenced through the heads with air motors on centers opposite the seams. After drilling each set of four holes, the plates were bolted up securely with 1⅛-inch bolts. This insured that there was no slack to take up, with the result that the plate edges met nicely at the joints when they were assembled.

It may be added that to prevent the possibility of the heavy plates cracking out from the holes on the roll up, all holes in the circumferential seams were slightly countersunk on both sides of the plate and the rough edges on the sides of the plates filed off. In addition to this, to insure a perfect joint at the butt, the butt joint ends were beveled about 3/16 inch. This was necessary because of the thickness of the plate. The layout being made from the neutral diameter and the true length of the plate being in the center, it was necessary to shorten the plate a little on the inside half. As it was, naturally the plates were slightly short on the outer half.

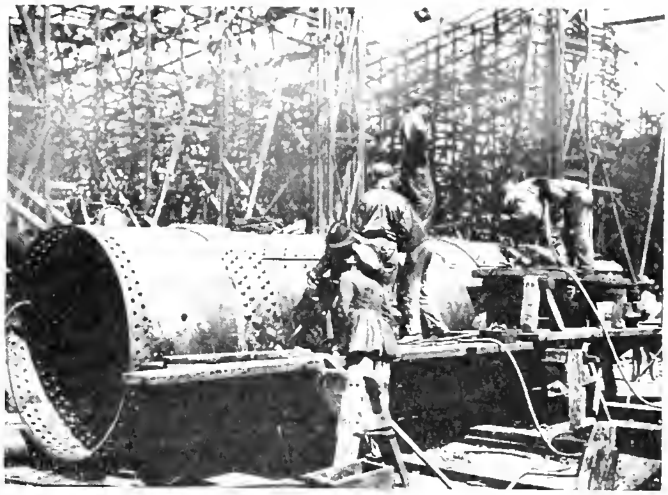
After the plates and heads were assembled, the welt straps with tack holes were bolted on, marked off, then taken down and drilled on a drill press. Later all flanges, plates and straps were assembled and all holes reamed to size. After this was done all parts were disassembled, all chips, cuttings and burrs removed and all parts reassembled. The parts were bolted up, heats taken and everything necessary was done to make the plates tight. In the test it was impossible to insert a 0.005 inch feeler between the plates. The tank was then riveted on the hydraulic riveter with pressures varying from 90 to 150 tons, according to the thickness of the plates and the sizes of the rivets.

The total weight of the shell being much greater than the capacity of the boiler shop crane, the two shell sections, after riveting were delivered to the erecting floor, there assembled and the one girth seam driven with a pneumatic hammer. Prior to the test, all girth seams except the heads were calked on the inside. All seams were calked outside. All girth rivets were also calked on the inside; that is, the seam which had been pneumatically driven.

The tank was built with a factor of safety of 4.85 to carry 350 pounds of steam. It was tested out at 525 pounds cold water. So well was the work done that there was barely a leak of any kind until the pressure reached 400 pounds, and very little after that. While the A.S.M.E. Code had had no special provision for *tanks* of this character it was built closely to this code for *boilers* of similar character and was inspected and passed by a boiler insurance company. In view of the character of the tank and the utter lack of combustibles in its operation it would seem that a lower factor of safety could profitably be used without in any way lessening the actual safety of the machine.

Heavy Plate Penstock Built for Recent California Power Development

MANY boiler concerns and plants equipped with machinery suitable for heavy plate fabrication have during the last year or two turned to tank and pipe line construction with great success. An example of such work occurred at the yard of the Los Angeles Shipbuilding and Dry Dock Company, where the facilities of the boiler and plate shop were recently employed in the fabrication of a penstock for the Southern Californian Edison Company, to be used to replace a section which failed in the pipe line from Big Creek to number eight plant of the Edison Company.



Heavy Pipe Constructed at Plant of Los Angeles Shipbuilding and Drydock Company

The penstock was 22 feet 3 inches long and 6 feet in diameter of steel 1 1/16 inches thick. Butt joint construction was employed, with interior and exterior butt straps, calked inside and out. About 1,600 1⅜-inch rivets were required in lining up the plates of this penstock. This penstock, weighing thirteen tons, was loaded on a six wheel chain-drive tractor Mack truck. In order that no delays might occur, three drivers were provided for the truck and a similar truck followed light in case of accident. The trucks left the plant of the shipyard going via Bakersfield to Fresno, shortly above which point they were met by a locomotive and flat car of the San Joaquin and Eastern Railroad. The railroad transported the penstock 70 miles to Big Creek whence an inclined railroad carried it 2,000 feet down to a second inclined railroad which dropped it another 800 feet to the concrete base prepared for it about seven feet above the ground against the side of the mountain. The penstock is called on to withstand a pressure of around 450 pounds to the square inch from water under an 800-foot head.

Fan Draft for Locomotives Discussed By A. S. M. E.

By Frans H. C. Coppus

The following is an abstract of a paper on the "Mechanical Drafting of Locomotives" presented at the annual meeting of the American Society of Mechanical Engineers. Methods of drafting by means of turbine driven fans, as outlined in the paper, offer a possibility of effecting great savings in fuel by permitting the application of additional economizing equipment.

GENERALLY speaking, it is a simpler task to incorporate extensive improvements into the design of a new locomotive than to apply them to one already in operation. Though the author would be the last person to discourage the development of the locomotive along radical lines that would require a total reconstruction or rearrangement of the present locomotive power plant, he believes that more can be accomplished for the immediate future by adding to the existing locomotive equipment which is standard, in principle at least, in stationary and marine practice, and which does not necessitate extensive or costly alterations. The existing locomotives, 68,000 in this country alone, represent such a large investment that no matter how efficient

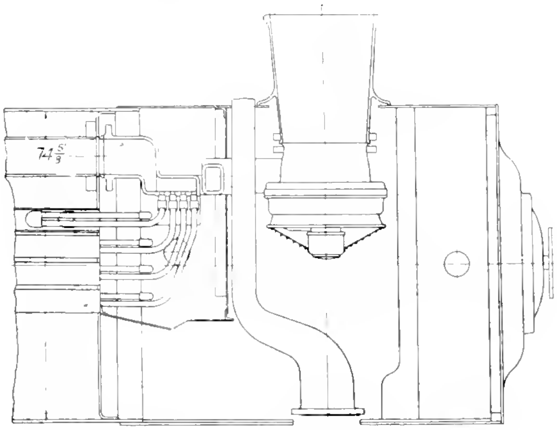


Fig. 1.—Modified Form of Standard Front End with Induced Draft Fan

a new locomotive may be built, it is out of the question to relegate them to the scrap heap, and they will be with us for many years to come.

In the treatment of this subject the author has therefore limited himself to the existing locomotive. The supporting data employed are based on modern steam locomotives equipped with superheater and brick arch and fed by means of a live-steam injector.

The use of the exhaust steam for drafting the locomotive makes the locomotive power plant differ in principle from the marine or stationary power plant. In the latter the boiler is an independent unit, while in the former the boiler and the engine are interdependent inasmuch as the exhaust of the engine creates the draft for the boiler and the shutting down of the engine renders the boiler inoperative. Separate the two by substituting mechanical draft for the exhaust jet and there is no reason why the locomotive power plant cannot be fitted out with the devices which have been responsible for the low cost of power generated in marine and stationary power plants. The problem is one of successful adaptation with reliability and moderate maintenance cost, within the present limitations of clearances and other conditions under which the locomotive must operate.

The logical course of development would be as follows: I mechanical induced draft, II undergrate forced draft, III condensing the exhaust steam, IV pumping the hot water from the tender through a waste-gas heater into the boiler, V operating condensing.

Mechanical Induced Draft

About ten years ago extensive experiments with mechanical induced draft were made on the Atchison, Topeka and Santa Fe, but they failed because of the "inability to secure a fan of sufficient capacity to properly handle the volume of gases" within the limitations of clearances.

It is doubtful if a fan without the introduction of an intensifying element can be built to overcome this difficulty. Only recently this new element has been brought out. It takes the form of stationary guide vanes held in a casing. The current of air leaving the propeller is radially subdivided by the individual vanes and taken up without shock. These guide-vanes, which have a curvature increasing in the direction of the rotation of the propeller, concentrate the air current and give it a further acceleration, so that a large part of the pressure is produced and a large part of the end thrust taken up by them. This new fan or blower is very much smaller than a multi-blade centrifugal fan of the same capacity, both of commercial construction. Because of this fact the former can be made applicable to the locomotive and the latter not.

Fig. 1 shows the smokebox of a modern locomotive fitted out with a blower in the stack and the exhaust pipe and nozzle displaced by a plain exhaust pipe discharging the exhaust steam into the atmosphere. The guide-vane casing takes the place of the lower part of the stack.

A modification of the fan is necessary in order that it may function properly as an induced-draft blower for locomotives, keeping in mind especially, simplicity of construction, low maintenance cost and assurance that the bearings are kept cool and well lubricated at all times, as the success of the whole scheme hinges not only on the capability of the blower to create the desired draft in the smokebox, but also to stand up under it. A special design has been prepared in which the fan is driven by high pressure steam acting on a turbine wheel at the periphery of the propeller. The revolving unit has oil cooled bearings and the end thrust is taken up by floating the shaft in oil under pressure.

Saving by Reduction of Back Pressure

One of the outstanding advantages of the use of an induced-draft fan instead of the exhaust jet for drafting the locomotive is the reduction of the back pressure in the cylinders. Prior to the experiments of the Atchison, Topeka & Santa Fe, a series of indicator cards taken from actual road tests of representative locomotives in various classes of service were prepared showing the initial pressure, mean effective pressure, back pressure, and indicated horsepower, and in addition the added mean effective pressure and indicated horsepower which could be obtained by reducing the back pressure to 4 pounds. These showed increases in indicated horsepower ranging from 18 to 30 percent for simple locomotives and an average of 53 percent for a Mallet compound.

The author understands that since these tests were made the exhaust nozzles have been opened up considerably so that the back pressures have been greatly reduced. It would be idle to estimate what saving in fuel would result from drafting locomotives mechanically due to reduction in back pressure. However, the field seems broad and the prospects bright for enormous savings along this line.

If the only effect of drafting locomotives mechanically was the elimination of the back pressure on the pistons, this would in itself be sufficient to deserve the keenest interest of those responsible for the economical operation of locomotives, but the subject embraces a great many other questions and vitally affects many features in connection with the economical generation and use of steam. Mechanical drafting gives the locomotive a degree of flexibility which it does not now possess.

The steam pressure may be picked up at will or allowed to drop, regardless of the amount of work the engine is doing.

This flexibility of draft makes it unnecessary to favor the engine at any time. The practice of favoring the engine on hills, often no doubt unavoidable under the present method of drafting, is not only wrong from the point of efficiency but cannot help but result in leaky tubes, increasing maintenance cost, and in shortening the life of the boiler.

The advantages of mechanical induced draft mentioned above largely relate to economy in the use of steam after it is once generated. In addition thereto mechanical draft has a strong bearing directly upon fuel economy and will greatly increase the overall boiler efficiency.

The heat loss due to combustible in cinders, estimated anywhere from 5 to 20 percent depending largely on the class of service, is generally classed among the "unavoidable losses." With a fan the constant flow of air through the fuel bed, while gradually changing in intensity, will not lift or tear the fire, and this loss, therefore, can be practically entirely eliminated.

Undergrate Forced Draft

To put the ashpan of a locomotive under pressure might prove impractical for several reasons. To overcome this difficulty the author has constructed a grate with hollow bars taking the air from a wind box to which the forced-draft blower is connected.

The forced-draft blower is of the same general construction as the induced-draft blower. It operates, however, in a horizontal position with no excessive end thrust and handles cold air. Therefore, the special lubrication, end-thrust balancing, and cooling features are unnecessary.

While it is not impossible to operate a forced-draft blower in conjunction with an exhaust jet, it is much simpler and better to connect it up to an induced-draft fan. The speed of the two blowers could be so adjusted—and after once adjusted, maintained—that there would be an atmospheric pressure condition in the combustion chamber, if carried to a nicety. This is very common practice with stationary and marine boilers. With the fire door open there would be no inrush of cold air nor any outward leaking of flames or gases. Such a condition is called "balanced draft." It can be effected only by the use of a forced-draft blower in conjunction with an induced-draft blower, jet blower, or stack. While in a locomotive boiler there is no boiler setting through which air can filter in, the draft over the fire is so much stronger than in stationary practice and the fire door (on hand-fired coal burners) opened so much oftener, that even greater economies than in stationary practice should result from balanced draft.

With forced draft there is no reason why cheaper grades of fuel could not be utilized, which will not only result in economy in the cost of fuel, but also in the cost of handling and storage of coal.

The air space in the grates may also be very small so that no fuel will be lost in the ashpan, and at the same time the grate will let sufficient air through on account of the air being delivered under pressure.

The forced-draft blower creates sufficient pressure to force the air through the fuel bed, leaving only the drawing of the gases through the boiler tubes to the induced-draft blower, and the latter may, therefore, be smaller or may be run at a lower speed than if used alone. For these various reasons it is easier and more efficient to use a balanced-draft system than merely induced draft.

Condensing the Exhaust Steam

When the locomotive is drafted mechanically all of the exhaust steam is available for whatever use can be made of it. Heretofore a small part of the exhaust steam has been used to heat the feedwater. This practice has been quite common in Europe but has been only recently successfully carried out on this continent and to only a very limited extent, less than one percent of American locomotives being thus equipped. The exhaust-steam feedwater heaters have been constructed on the principle of imparting to the water the maximum amount of heat with the minimum amount of exhaust steam because the latter was needed to draft the

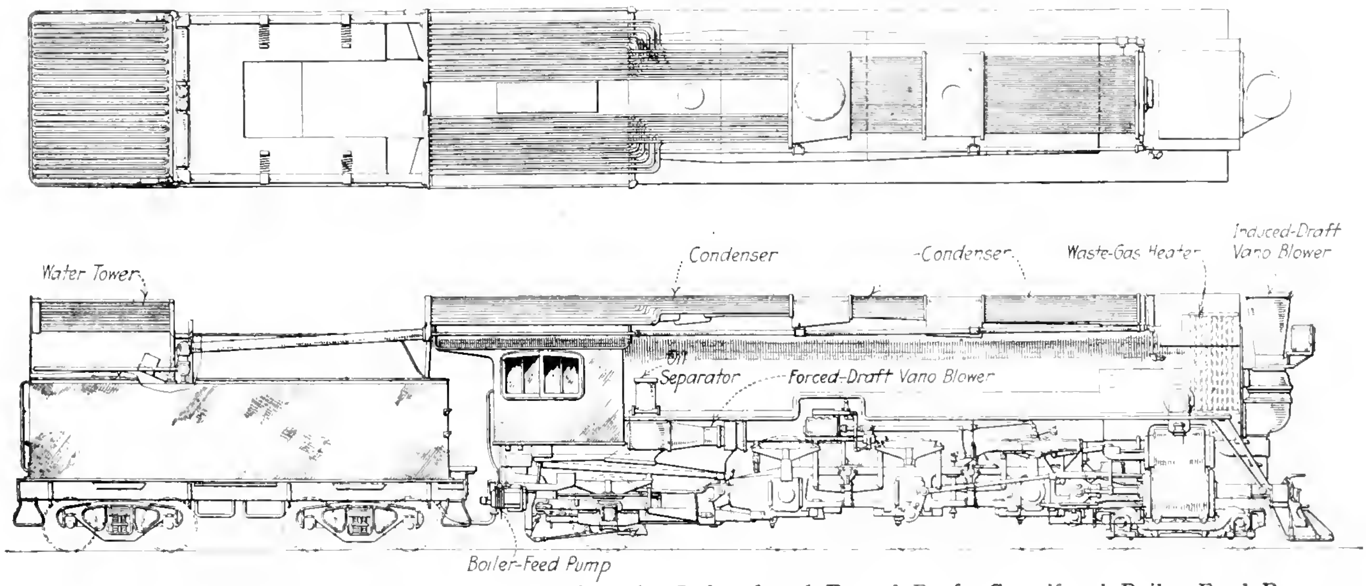


Fig. 2.—Proposed General Arrangement of Locomotive with Induced and Forced Draft, Centrifugal Boiler Feed Pump and Steam Condensing Apparatus

locomotive. With mechanical draft, the more steam used for heating the feedwater the better, as the more water will be saved. Railroad men fully appreciate the economy in time and fuel due to the saving of water, especially in freight service, and incidentally the not negligible economy in boiler repairs in bad-water districts.

Pumping the Hot Water from the Tender Through a Waste-Gas Heater into the Boiler

The exhaust steam, or as much of it as can be condensed, may be passed through a condenser on top of the locomotive running all the way back to the tender (see Fig. 2). The remainder may be allowed to pass to the air free for the time being. Such an arrangement affords a large cooling surface and the amount of water which can be saved without even attempting to run the engine condensing will be much larger than the amount saved by merely heating the feedwater by means of an efficient heater. The cooling surface may be made more effective by directing over it a current of air created by the speed of the locomotive with or without

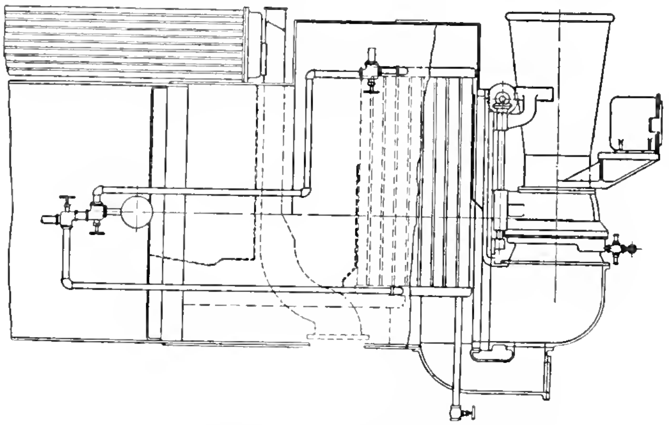


Fig. 3.—Modified Front End, Equipped with Induced Draft Fan and Feed-Water Heater

the assistance of the undergrate-draft blower. It is a simple matter to encase the condenser, provide it with louvers to catch the air, and connect it to the blower inlet by means of a duct. This would have the additional advantage of reclaiming part of the latent heat of the exhaust and supplying the fuel bed with preheated air. A cooling tower located in the back of the tender would further assist materially in condensing the exhaust.

It needs no explanation that with all the exhaust steam available it will be a simple matter to keep the water in the tender at any temperature desired up to the boiling point. This would convert the tender practically into an open heater. Instead of the injector a boiler-feed pump, preferably of the centrifugal type, installed in duplicate, will feed the water through a waste-gas heater into the boiler. The pumps will be located under the cab of the locomotive, so that there will be a sufficient head of water from the tender. Waste-gas heaters have been so far a distinct failure largely on account of the prerequisite that the heater should not interfere with the draft, because if it does the economy derived from its use would be nullified by an increase in back pressure.

The author has constructed a waste-gas heater which can be placed in the front end with slight alterations thereto, and which has a heating surface of over 1,000 square feet. By extending the front end this heating surface could be increased if necessary.

From the point of efficiency it may be considered that at the present time the water is put in locomotive boilers at an average temperature of 60 degrees F. the year round. If, instead of an injector, a pump is used the exhaust steam and the waste gases—which comprise the two largest items of waste energy in present locomotive operation—can heat the water from 60 degrees to 300 degrees. With an absolute steam pressure of 200 pounds this is an undisputed saving in fuel of a little over 20 percent.

Operating Condensing

Mechanical drafting of locomotives makes it possible to run locomotives condensing. It can be accomplished without material change in their construction outside of an enlarged and modified tender. This, however, will come later after the steam consumption of the locomotive has been made as small as possible, which will, in itself, make condensing operation easier.

General Arrangement

Fig. 1 shows the induced-draft blower located in the stack. This is naturally the logical first step in the development of an induced-draft system for a locomotive, but a blower in such a position is not readily accessible. Practical considerations led the author to place the blower outside of the smokebox. A diagram showing the general arrangement of exhaust pipe, waste-gas heater, and induced-draft blower is shown in Fig. 3 and will need no further explanation.

Means are provided whereby the guide-vane casing can be quickly separated from the fan casing, giving access to both the fan and the guide vanes for cleaning. Automatic adjustment is provided for maintaining the proper relation between the pressure at the grate bars caused by the forced-draft blower and the draft at the front end caused by the induced-draft blower. The speed of the fans is controlled to keep the boiler pressure from varying more than 10 pounds.

The induced-draft blower not only furnishes the necessary draft but also controls the amount of fuel used and the water fed into the boiler. Proper provision is made whereby the steam supply to the different apparatus is partly shut off when the engine is standing, or drifting.

Whatever the saving in fuel will be, due to the elimination of back pressure, the heating of the feedwater, the stopping of the waste of unburned coal through the stack and through the grate, the elimination of cold air over the fire, etc., it is going to reduce just that much the amount of coal that is being fired, or the rate of combustion, which in itself greatly increases the boiler efficiency.

A rate of combustion of 100 pounds shows a boiler efficiency of 65 percent. Reducing this rate of combustion to 60 pounds, directly and indirectly by means of mechanical drafting, which is not impossible, the corresponding boiler efficiency would be 74.2 percent, or a saving of 9.2 percent.

In a paper presented by John E. Muhlfeld, at the annual meeting of the American Society of Mechanical Engineers, December, 1919, entitled Scientific Development of the Steam Locomotive, the following heat balance is shown as representative of locomotives worked at from 25 to 35 percent cut-off and hand-fired:

	Percent
Heat absorbed by boiler	55
Heat absorbed by superheater	10
Heat loss in smokebox gases	14
Heat loss in cinders	8
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	3
Heat loss in carbon monoxide	2
Heat loss in radiation and unaccounted for	4
Total	100

Under the same conditions but with mechanical draft and the waste-gas heater as described by the author, the heat balance should be approximately as follows:

	Percent
Heat absorbed by boiler and waste gas-heater	74
Heat absorbed by superheater	10
Heat loss in smokebox gases	5
Heat loss in cinders	2
Heat loss in vapors of combustion	4
Heat loss in combustible in ash	1
Heat loss in radiation and unaccounted for	4
Total	100

In conclusion, it may be stated that mechanical drafting of locomotives is imperative for the following reasons:

(*a*) It reduces the back pressure to a minimum, effecting a saving in fuel of from 10 to 30 percent; or increasing the power of the locomotive in the same degree, especially as speed increases, therefore adding to the hauling capacity or speed of fast freight and passenger engines, producing additional revenue tonnage and also eliminating or lessening the necessity for double-heading.

(*b*) It produces an engine that is free-steaming under the most adverse conditions and with all grades of fuel, decreasing liability of delay and saving time and money now spent in changing nozzle tips and experimenting with them.

(*c*) It keeps the steam pressure constant, regardless of load, saving steam now wasted every time the safety valve pops and making it unnecessary to favor the engine at any time, thereby saving fuel, avoiding unequal stresses in the boiler and resulting in saving in maintenance cost.

(*d*) It increases the efficiency of the boiler and grate by effecting better combustion and eliminating the waste of unburned fuel through the stack and in the ashpan—and incidentally stopping the inrush of cold air every time the fire door is opened—thereby avoiding sudden cooling of crown sheet and tubes.

(*e*) It makes possible the use of cheaper grades of fuel, resulting in large economies and in simplifying the handling and storage of coal.

(*f*) It eliminates the smoke nuisance in terminals and freight yards.

(*g*) It makes it possible to condense from 25 to 95 percent of the exhaust steam, depending upon the season of the year and the kind of condensing apparatus used, resulting in economy in the cost of water and of maintenance.

(*h*) It effects a saving in fuel of 20 percent by making it possible to preheat the feedwater from 60 to 300 degrees F., and incidentally greatly decreases the cost of maintenance by eliminating unequal stresses caused at present by the great difference in temperatures between the lower and upper portions of the boiler.

(*i*) It reduces the rate of combustion, thereby increasing the boiler efficiency.

(*j*) It lessens the work of both engineer and fireman, thereby necessarily increasing their efficiency.

Discussion

William Elmer (Pennsylvania System) questioned the desirability of making the boiler output independent of the locomotive steam consumption. To show the great amount of air that it would be necessary to handle with a fan if locomotives were drafted mechanically, he presented figures from test plant trials of a Pacific type locomotive with 27 inch by 28 inch cylinders. This locomotive developed over 3,000 horsepower, evaporated 65,000 pounds of water and burned 12,000 pounds of coal an hour. The draft in the front end was as much as 18 inches of water. It is difficult to determine the amount of air required to burn each pound of coal, but J. T. Anthony states it varies from 12.7 to 8.7 pounds. Assuming an average value of 10 pounds of coal and assuming further that a locomotive consumes 10,000 pounds of fuel an hour, the fan would be required to handle 100,000 pounds of air per hour. This would amount to 1,300,000 cubic feet per hour at atmospheric pressure, and at a temperature of 600 degrees, which might be expected in the front end, the volume would be double.

Robert Rennie (American Locomotive Company) stated that a locomotive with 55 square feet of grate area working at full capacity should have a fan capacity of at least 48,000 cubic feet per minute at atmospheric pressure. Cooling the air before it is admitted to the fan would make mechanical drafting less difficult, but the additional resistance due to any appliance for recovering heat from the waste gases is a disadvantage. He considered that the method of reclaiming water from the exhaust steam would hardly be practical because of the enormous cooling surface required.

W. L. Bean (N. Y., N. H. & H.) called attention to the magnitude of the fuel problem on the railroads and pointed out the desirability of trying such designs as proposed by Mr. Coppus because of the possibility for large savings. He stated that fan efficiency and capacity had been greatly improved since the last trials of mechanical draft.

Dr. W. F. M. Goss discussed mechanical drafting of locomotives by means of a turbo-exhauster. He called attention to the objection of the operation of locomotives in cities on account of the noise and smoke and outlined how these could be overcome by the turbo-exhauster. He stated that the required draft could be obtained with from 40 to 50 percent of the existing back pressure, and in conclusion expressed the opinion that mechanical drafting had so many advantages that it is likely to come into use soon on the railroads.

In closing the discussion, Mr. Coppus stated that his proposal had in some cases been misunderstood due to failure to consider all the conditions set forth in the paper. His conclusions had been based on careful study and he felt certain that they were practical.

Chinese Board Specifies A. S. M. E. Boilers

In a recent communication, William Althoff, Assistant Chief, Industrial Machinery Division of the Department of Commerce, Washington, D. C., states that the Department has received copies of specifications for tenders invited by the Min River Conservancy Board, Foochow, China, for a steam-operated river-type hydraulic dredge for improving the channel of the Min River; tenders to be in the hands of the Board not later than February 15, 1923. These specifications include the following clauses:

Boiler. The boiler shall be constructed in accordance with the specifications of the Boiler Code Committee of the A.S.M.E.—or other equivalent specifications.

Hull. The steel used in the hull shall meet the requirements of the specifications for structural steel for ships of the American Society for Testing Materials—or other equivalent specifications.

The Min River Conservancy Board, although a Chinese Government organization, is, through their representation on it, under the virtual power and control of the commissioner of customs and the foreign consular representatives and representatives of foreign commercial bodies. Its funds are supplied by a surtax on the regular customs tariff and the funds are administered by the Board though collected by the customs. The engineer in chief is an American.—*Mechanical Engineering.*

The Problem of Rebuilding Locomotives.—One of the problems which the railroads have had to face in recent years has been to obtain a well balanced design in rebuilt locomotives. Boiler accessories include practically all the modern appliances for increasing economy but, if the boiler is rebuilt with the addition of such devices, the cylinders should also be enlarged. Stresses on the main rods, frames, and the like are also greatly increased, so that practically a whole new machine is necessary. By applying such devices as those for utilizing the trailer or tender wheels for increasing the tractive force, the capacity of the boiler at low speed can be utilized. At higher speeds the main cylinders would be able to utilize the full boiler output by running at a slightly longer cutoff. Thus from the engineering standpoint, the introduction of auxiliary devices for increasing tractive force offers new possibilities for obtaining a well balanced design in locomotives.—*Railway Mechanical Engineer.*

Vertical Type Boiler Explodes on a British Ship

Details of Board of Trade Investigation With Conclusions by the Engineer Surveyor-in-Chief

A RECENT Board of Trade report covering a tube explosion in the main vertical, cross-tube type boiler on the steamship *Ixion* indicates the extreme thoroughness with which investigations of what in this country would be considered minor explosions are undertaken.

The explosion occurred at sea, four miles off Kinnaird Head, while the vessel was on a voyage from Bridgeness to Stromness. The vessel was owned by The East Coast Salvage Company, Limited, Dundee, Scotland. No person was injured by the explosion.

Description and Principal Dimensions of Boiler

The boiler was of the vertical, cross-tube type, 15 feet in height and 6 feet 3 inches in diameter, made of steel, and worked at a pressure of 95 pounds per square inch. The firebox, which was 5 feet in diameter, had four horizontal steel cross-tubes, 12 inches in diameter and 3/8-inch in thickness. There were six handholes, for cleaning purposes, 8 inches by 5 inches; four were opposite the cross-tubes and two were at the bottom of the water space and close to the fire-door. The usual boiler mountings were fitted.

The boiler was not new when fitted on board the *Ixion*, in 1915, and the name of the maker and age of the boiler could not be ascertained.

Particulars and Dates of Repairs

The firebox, uptake and cross-tubes were renewed in 1915, previous to placing the boiler in the ship. It was not possible to obtain particulars of repairs done, if any, between 1915 and 1920, while the vessel was on government service, but no repairs had been done to the boiler by the present owners.

The boiler was inspected in December, 1920, by a consulting engineer, of Dundee, when he surveyed the ship at Glasgow on behalf of the present owners, before purchase, and it had been examined twice since then by the mechanical engineer in charge of the salvage plant at the company's depot, Dundee. The boiler was not insured.

Nature of the Explosion

The right hand lower cross-tube was bulged in two places on the underside and the plate was torn apart, forming a ragged hole 3 inches in length and varying between 1/8-inch and 1/4-inch in breadth, and through this opening water and steam escaped from the boiler.

The explosion was apparently caused by overheating of the cross-tube, under working conditions, due to a deposit of oil and scale.

The *Ixion* was a small steamer with a crew of four persons, two on deck and two in the engine room, and was used mainly for the transport of salved cargo from wrecks. The boiler on board had been previously used by the Glasgow Steam Coaster Company, Limited, Glasgow, in one of their vessels; and it was thoroughly repaired in 1915, when the ship was requisitioned by the Government for war service. This firm is now out of business and their records are destroyed.

Events Leading to Explosion

The voyages made recently were often coastwise, and, at times, were so long that the supply of fresh water—eight tons—carried for the boiler was not sufficient, and, on a trip to the Orkney Islands, it became necessary to use sea water for supplementary feed. On March 7, 1922, the engineer-in-charge for the first time, stated that he noticed signs of salt water in the boiler at that time, and, as there was not a salinometer on board, he asked the skipper to get one. The skipper promised to try and obtain the loan of one, but never got it. The engineer resorted to blowing down the boiler frequently in order to freshen the water inside. He admitted having put in a demand for stores at Dundee in April, 1922, without including a salinometer in the list, and said that he still expected the skipper to get one and that the need did not seem urgent as so much fresh water was obtainable when the ship was in port.

Between May 8 and May 22, the *Ixion* was standing by the steamship *Thistlemore,* stranded at North Berwick, and carrying salved cargo to Leith. This cargo was chiefly bags of flour thickly coated with oil fuel which had escaped from the bunkers of the *Thistlemore*. The drainage from the oily cargo accumulated in the bilges of the *Ixion* and was being constantly pumped overboard but, when the vessel was not under way, the auxiliary pump used for the bilges was the same as that for feeding the boiler. The vessel was in Tayport on June 2, 1922, and the engineer having reported that the boiler was dirty, understood that it would be cleaned a day or so later. He left the same day for another post.

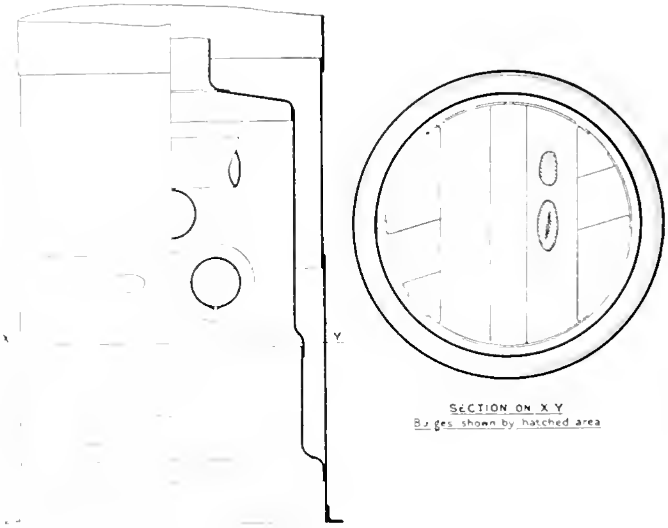


Diagram of Failure in Cross Tube of Vertical Marine Boiler

The new engineer, when he joined the *Ixion*, stated that he noticed a lot of fuel oil in the bilges, and that he tried the density of the water in the boiler with a salinometer which was his own property and found it to be fully 2/32. This was reduced to 1/32, during the next two days, by blowing down.

Four days later, while on a voyage to the Orkney Islands, the explosion occurred. The fireman was on watch at 3:30 A. M., and had raked the fire and gone on deck for a few minutes. He was just starting to descend the engine room ladder when there was a rush of steam from the boiler furnace. He called the engineer, but it was a quarter of an hour later before they were able to go below. The engines were still running and about 80 pounds pressure was showing on the gage. The boiler fire was found to be extinguished and it was seen that the right hand lower cross-tube had failed, as above described.

The *Ixion* was towed to Fraserburgh, where the tube was patched and she then proceeded to Stromness and returned to Dundee, where the tube was taken out of the boiler. The tube was found to be hogged about ⅛-inch, as might have been expected from working conditions, and the position of the defects, as ascertained, was as shown in Fig. 1.

The supervision of the care and maintenance of the boiler was left to the salvage company's engineer at Dundee. He arranged to examine the boiler twice a year, at convenient times; and it was emptied and cleaned for his examination in April, 1921, and in January, 1922. He had intended to examine it next when the vessel came back from Stromness in June, 1922; and it appears that these examinations were the only times when the boiler was opened and cleaned. He also stated that at each examination the condition of the boiler was satisfactory, and that the amount of scale to be removed was small. Further, he stated that it was unknown to him that the engineman had not been in charge of engines and boilers before and understood that he had been recommended to the skipper at Arbroath as having been an engineman in fishing craft. He did not think it necessary, therefore, to exercise extra supervision in his case.

When the boiler was opened out at Fraserburgh on June 9, 1922, the damaged tube was found to have a deposit of scale, about ¾ inch in thickness, firmly attached to the lower part. There was a considerable amount of black grease in this scale, and free oil was also present in other parts of the boiler. At the point of failure there was a clear indication of overheating.

There is no doubt that, although both engineers stated that they took great care to wash through the donkey pump after using it on the bilges, the boiler must have been fed frequently with water which was contaminated with oil. Moreover, the period which was allowed to elapse between each cleaning was too long for a boiler of this description, and it does not seem to have occurred to anyone concerned that there was a danger from oil finding its way into the boiler. It is very undesirable for a pump with a bilge connection to be used for feeding a boiler, and if this boiler had been cleaned at Tayport at the beginning of June, just after the *Ixion* had returned from the *Thistlemore,* it is most probable that the explosion would not have occurred.

The owners have since had the boiler insured and it is now subject to periodical inspection.

The failure of this tube was apparently due to a heavy deposit of lime scale, this being no less than ¾ inch thick on the interior surface of the tube.

The working equipment was somewhat deficient as the feed pump was also used as a bilge pump, in consequence of which oil from the bilges was pumped into the boiler and oil in boilers frequently leads to overheating. Although sea water was sometimes used as feed, no instrument for ascertaining the density of the boiler water was provided, and internal inspection and cleaning of the boiler was carried out only once every six months. Altogether, the method of working described above was such as might be expected sooner or later to lead to a serious mishap. Fortunately no person was injured by the escape of steam and hot water.

Water Used With Sand Blasting Machine to Eliminate Dust

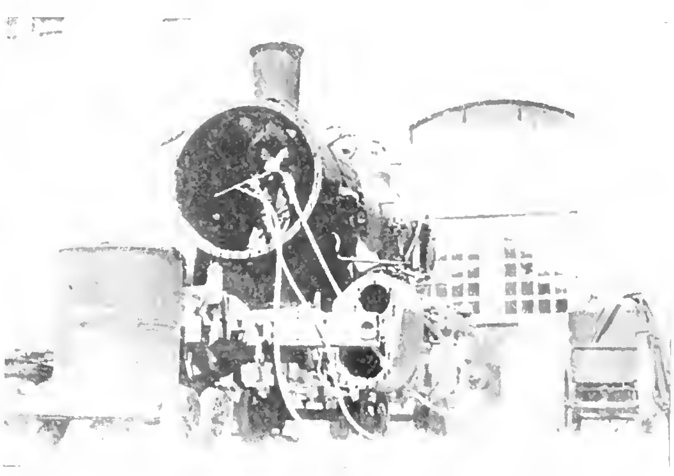
One of the disagreeable effects of sand blasting in boiler work has been eliminated at the Southern Pacific shops at San Francisco by mixing water with the sand in the sand blasting machine. Instead of sand and dust flying all over, the water carries it away from the part of the boiler that is being cleaned, leaving an absolutely smooth job.

As shown in Fig. 1, the device consists of a 16-inch by 42-inch tank which can be mounted on a 4-wheel truck for easy movement about the shop. Suitable hose connections are provided to the air supply and water supply, the latter being used to keep down the dust. Air is furnished from the shop mains through a flexible hose to a line of 1-inch pipe and fittings beneath the tank. An auxiliary ½-inch pipe is connected to the top of the tank and admits air through the valve on top of the sand. The tank can be filled with sand through the funnel and valve shown. Other valves are located in the lower pipe lines as shown and a ½-inch pipe to the bottom of the tank facilitates keeping the sand in agitation so that it will readily fall through the 1-inch pipe to the moving air column. Air and sand are delivered through the flexible hose, brass reducer and two Y branches to a ½-inch pipe which the operator uses in directing the final flow of air, sand and water.

In operation the tank is filled with dry screened sand and the valve on top closed. With main air pressure on the tank sand falls on the rapidly moving stream of air which carries it to the blast nozzle. The reducer has a tapered hole (¼ inch at the smallest diameter) which automatically controls the amount of sand. The sand is moistened with water to keep down the dust and is finally ejected by the independent air hose connection.

(Keystone View Co., Inc., N. Y.)

Fig. 1.—Equipment for Sand Blasting Utilizing a Hydraulic Attachment to Eliminate Dust



(Keystone View Co., Inc., N. Y.)

Fig. 2.—Sand Blasting Outfit for Boiler Cleaning in Service Cleaning the Smokebox of a Locomotive

Standard Tests to Determine Strength of Welds

Test Specifications of the American Bureau of Welding Designed to Compare the Effectiveness of Welded Joints

A NUMBER of months ago the American Bureau of Welding, through a special committee on "Standard Tests for Welds," prepared complete specifications for comparing the strength and quality of various types of welds. Many of our readers have from time to time requested data of this nature on welding and so it was thought advisable to publish the complete rules of the American Bureau which represent the best practice in this particular line of work.

The committee in preparing the "Standards for Testing Welds," which are transmitted herewith, proceeded on three assumptions as follows:

1. The fundamental basis of measuring the effectiveness of a joint between two pieces of metal, is the same as metal without a joint. A joint is a necessary evil in a structure which is avoided when it is possible. Therefore, the value of a joint is best determined by comparing the characteristics of a section of the structure which includes the joint with those of a similar section which has no joint. In other words, a weld is a joint and the practical basis of evaluating a weld is in terms of the metal of the parts joined together.

2. Three standards are desirable, as follows:

(a) *Shop Standard.* In the shop a standard test is required for such purposes as checking the work of a welder from time to time, testing a new lot of electrodes in electric welding or of welding wire in gas welding, testing the effect of some change in conditions which may have taken place, etc. Such a standard must necessarily be as simple as possible and preferably a single test. The technique of the procedure in making the test must be of a simple character.

(b) *Commercial Standard.* There are many cases where more than one kind of test should be made, but where the circumstances do not justify a complete investigation. There is, therefore, a need for what might be termed a commercial standard for making, for example, comparisons between different commercial welding processes or between different kinds of electrodes in electric metal arc welding or different wires in gas welding.

(c) *Research Standard.* When a complete investigation of a weld is to be made for research or other purposes, all tests and examinations are made which will contribute any information in regard to the characteristics of the weld. It may be necessary to make tests of a special character in special kinds of welds or where application under unusual conditions is contemplated, but there should be a standard list of tests which will give information which is complete as far as all ordinary requirements are concerned.

3. The details of the procedure in making the various mechanical tests should be carefully prescribed. It is believed by the committee that standardization in this respect is of the greatest importance, because comparatively small differences in procedure have a marked influence in certain mechanical tests and unless these are eliminated the results are not comparable.

Standards for Testing Welds

Note—These specifications are intended primarily to serve as a standard uniform basis for testing and comparing *sample* welds as distinguished from welds in structures. The testing of the latter must necessarily be by non-destructive methods which would therefore be, in general, quite different from those employed in examining sample welds (test welds) made, for example, for the purpose of testing a welder's proficiency, comparing welding wires or comparing welding methods.

I. Definitions

The following are definitions of terms employed in this specification:

(a) A *Weld* is a solid union of metallic pieces formed by uniting or consolidating by hammering or compressing with or without previous softening by heat.

Note—This definition is quoted from the Century dictionary. It is the broad definition of a weld and therefore includes forge welding and resistance welding by either the butt or spot process. While these specifications are prepared specifically for fusion welds, it is obvious that some of the tests can be applied to other types of welds.

(b) A *fusion weld* is a weld formed by heating to a fluid state the edges of the pieces to be joined and allowing the metals to flow together (with or without additional molten metal being supplied) without any pressure being applied. The heat may be supplied by a gas flame, an electric arc, thermit or otherwise.

(c) In a fusion weld, the *base metal* is the material composing the pieces to be united by the weld. Unless otherwise expressly stated, it will be understood that a weld joins two pieces of identical material.

(d) In a fusion weld, the *weld metal* is the material which has been used in forming the weld. It may consist entirely of a base metal adjacent to the weld or of the material added to the fused base metal from a welding rod or electrode, or other material.

(e) *Filling metal* is the metal added during the welding process to form part of the weld. In gas welding it is supplied by means of a *welding rod*, in carbon arc by a *filling rod* and in metal arc welding by the *electrode*.

(f) A *test weld* refers to a sample of welding which has been performed under known conditions and upon which mechanical tests are to be made.

(g) A *test specimen* is a prepared piece on which a mechanical test is to be made.

II. Shop Standard

Bending test only.

III. Commercial Standard

(a) Bending test.

(b) Tensile test.

Note—It is probable that eventually it will be desirable to include a fatigue test when a method is standardized which will be suitable for commercial application.

IV. Research Standard

A. *Tests of base or parent metal.*

1. Chemical analysis. To include carbon, manganese, silicon, phosphorus and sulphur.

2. Mechanical tests.

(a) Tensile. To include yield point, ultimate strength, total elongation and reduction of area.

(b) Bending.

(c) Fatigue.

3. Metallographic. Photomicrographs at 100 diameters.

B. *Test of weld.*

1. Mechanical tests.

(a) Tensile. To include yield point, ultimate strength, total elongation and reduction of area.

(b) Bending.

(c) Fatigue.

(d) Impact.

2. Metallographic. Photomicrographs at 100 and 500 diameters, respectively, at (a) the junction between the

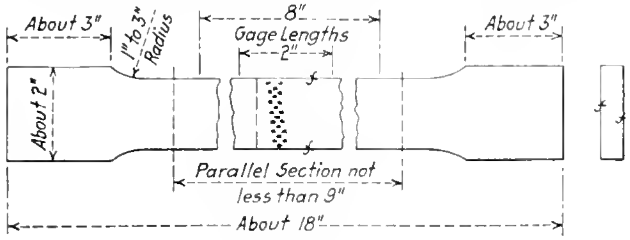


Fig. 1.—A Test Specimen for Sheet Materials

base metal and the filled-in metal, (b) the base metal adjacent to the junction, (c) the center of the filled-in metal.

C. *Tests of filled-in metal.*

1. Chemical analysis. To include carbon, manganese, silicon, phosphorus and sulphur.

2. Mechanical tests. Standard round specimens to be prepared from ingots deposited in a base-metal mould of such dimensions that normal cooling conditions will be approximated.

(a) Tensile. To include yield point, ultimate strength, total elongation and reduction of area.

(b) Bending.

(c) Fatigue.

3. Metallographic. Photomicrographs at 100 and 500 diameters, respectively.

V. Standard Procedure for Mechanical Tests

1. *Preparation of test welds.*

No detailed instructions for the preparation of test welds can be given as the dimensions, material, etc., will depend upon the purpose for which the weld is being made. The test weld should, however, duplicate as nearly as practicable, the commercial welds which it represents and should preferably be of such a size as to permit preparation of enough specimens from the one test weld to make all of the mechanical tests which are to be made.

When the test weld is made with material in sheet or plate form, the longest axis of the test specimen should, in general, be parallel to the direction of rolling.

2. *General Procedure.*

(a) Wherever applicable, the standard procedure of the American Society for Testing Materials as given in the A. S. T. M. for 1918 (serial designation E-1-18) shall be followed.

(b) Three duplicate specimens shall be tested in any one test and the average taken as the value of the property determined by this test.

3. *Tensile Tests, Base Metal.*

A. TEST SPECIMENS

(a) *Sheet or Plate Material.* The test specimen for sheet materials is shown in Fig. 1. The thickness of the specimen may be any that is desired, but a thickness exceeding 3/4 inch would require a testing machine in excess of 100,000 pounds capacity. If the specimen is cut from standard sheet material, it is usually not necessary to machine the 1.5 inch faces of the specimen.

(b) *Cast Material.* The test specimen for cast or brittle materials is indicated in Fig. 2.* It is particularly important to use swivel specimen holders when testing such specimens in order to entirely eliminate undesirable stresses.

B. TEST RESULTS TO BE RECORDED

(a) *Ultimate Strength.* Unit stress pounds per square inch computed from the area of the original section.

(b) *Yield Point.* Unit stress pounds per square inch at which marked increase in deformation of the specimen occurs without increase of load as indicated by a sudden dropping of the beam of the testing machine or by a sudden increase of the rate of elongation as shown by dividers.

(c) *Contraction of Area.* Expressed in percent of the original area.

(d) *Appearance of Fracture.* The appearance of the fracture as determined with the aid of a low power magnifying glass (such as jewelers use) should be recorded. The characteristics described by the following nomenclature should be covered, indicating as far as possible the percent of the total area which is involved. For example, "10 percent not welded" would signify that approximately 10 percent of the total area of cross section at the fracture is exposed base metal—that is, not welded.

Spongy: Full of small cavities; the structure resembles that of a sponge; porus.

Slag inclusions: Foreign matter entrapped in the weld.

Gas pockets: Small or large cavities, more or less isolated (*i.e.*, not of a regular spongy structure).

Not welded: Exposure of any portion of the surface of the base metal indicating imperfect fusion between the base metal and the filling metal.

Laps: Imperfect fusion between adjacent portions or between successive layers of filling metal.

(The recording of the following data is optional.)

(e) *Proportionality Limit.* Unit stress (pounds per square inch) at which the deformation ceases to be directly proportional to the load.

Any type of extensometer may be used, but in precise work the deformations of two opposite elements of the specimen, preferably on the edges, should be obtained. For ordinary purposes deformations in only one element of the specimen need be measured, but in that case the gage marks should be on the center of the line of the 1.5 inch side.

The gage length may be either 2 or 8 inches.

(f) *Modulus of Elasticity.* Unit stress (pounds per square inch) computed from data obtained from a specimen having an 8-inch gage length; measurements to be taken on two opposite elements, one on each edge of the specimen.

(g) *Total Elongation.* Gage marks shall be laid off every inch along a line at the center of one of the 1.5-inch faces of the specimen before placing in the testing machine and the total elongation in every inch after rupture recorded. The total elongation in the 1-inch, 2-inch and 8-inch (if any) length, which included the break shall be reported.

4. *Tensile tests, weld metal.*

A. TEST SPECIMENS

The shape and dimensions of the test specimens are shown in Fig. 2. It shall be prepared from a bar of *weld metal*, 3/4 by 1 by 11 inches. This bar shall be formed entirely by depositing filling metal in an open box of the shape shown in Fig. 3, employing exactly the same method used in making the corresponding *test weld*. For metal electrodes this box shall consist of a copper plate 1/2 inch

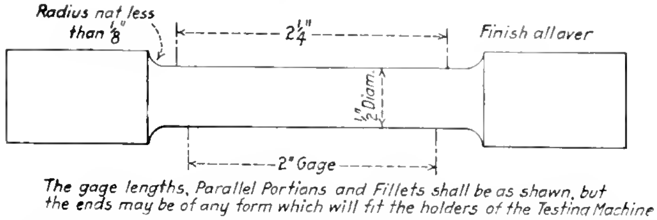


Fig. 2.—Specimen Used in Testing Cast or Brittle Materials

*The diameter of this specimen may be 0.505 inch if desired. This diameter gives an area of exactly 0.200 square inch thick, upon which is secured a frame of steel bars, ¾ inch square. The parts of the box were secured in any convenient manner. The copper plate, during this operation shall rest upon a steel plate. After the bar is formed, the

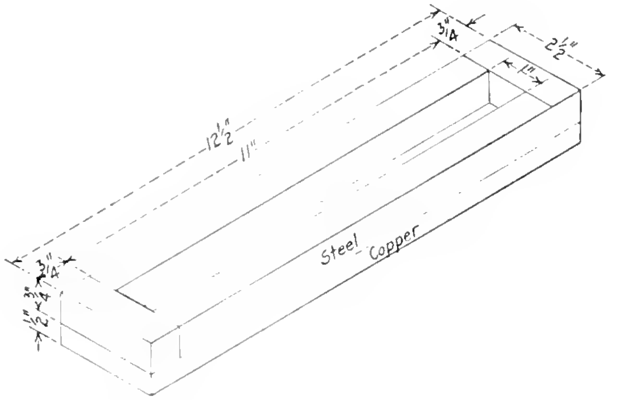


Fig. 3—Box Used in Forming Bar Entirely of Filling Material

copper plate and the frame may be removed by any suitable machining operation.

For gas welding, the copper plate should be replaced by a steel plate. For thermit, a box of suitable refractory material should be used.

B. TEST RESULTS TO BE RECORDED

These shall be the same as those prescribed in Section V, 3-B (base metal) except those involving an 8-inch gage length. If, however, the modulus of elasticity is desired, a specimen similar to that shown in Fig. 2, with a gage length of 8 inches shall be employed.

5. *Tensile Tests, Weld.*

A. TEST SPECIMENS

The shape and dimensions of the test specimen are shown in Fig. 1 with the weld at the center. If the material is cast or brittle, the specimen shown in Fig. 2 shall be used with the weld located at the center.

It is especially necessary that the 1.5-inch sides of the specimens be machined, particularly if the two pieces of base metal are offset or if they form an angle at the weld. Tests made in the latter case, where the specimens are not machined, are not reliable. Furthermore, care must be taken that specimens having the latter defects are not "straightened" before being machined, because such treatment is likely to materially decrease the strength of the

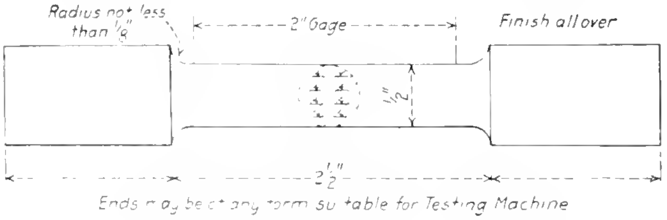


Fig. 4.—Test Specimen of Round Cross Section

weld. A roughening cut in a planer or shaper which will just "close up" the surfaces of the specimen is sufficient.

B. TEST RESULTS TO BE RECORDED

The requirements for test results given in Section V, 3-B (base metal) shall be followed.

6. *Bending Tests, Base Metal, Weld Metal and Weld.*

A. TEST SPECIMENS

(a) *Base Metal and Weld.* The shape and dimensions of the specimen are shown in Fig. 5.

In the case of welds in flat rolled material, the surface of the weld shall be machined substantially flush with the surface of the specimen unless the specimen is bent or offset, in which it shall be machined all over. Cast and other

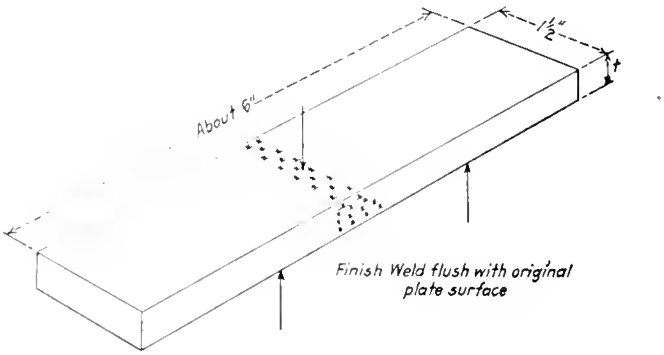


Fig. 5.—Specimen Used for Bending Test

irregular specimens shall be machined all over. It is essential that the edges of all specimens be machined to remove material in a condition likely to cause premature failure.

The thickness, *t*, of a weld specimen shall be as nearly that of the base metal as possible.

(b) *Weld Metal.* A specimen may be prepared from a bar of weld metal prepared as prescribed for tensile tests. The box, Fig. 3, shall, however, have a width of 1.75 inches and the thickness, *t*, of the specimen shall be that of the test weld. These specimens shall be machined all over.

B. APPARATUS

In order to load the specimens so that as large a part of the bend as possible shall occur in the weld metal, the

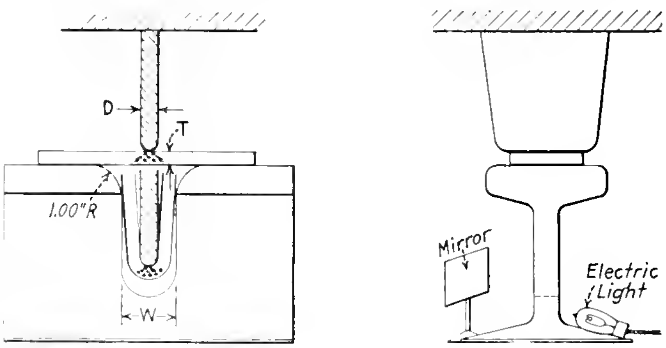


Fig. 6a Fig. 6b

Figs. 6a and 6b.—Sketches Showing Side and End Views of Apparatus Used in Making the Bending Tests

special fixture outlined in Figs. 6a and 6b shall be used. It is most conveniently used with any standard universal testing machine, but may be operated by any other convenient mechanical means.

The cylindrical surface, D (Fig. 6a), about which the specimen is bent shall conform to the requirements of the American Society for Testing Materials for bending tests of the base metal.* This piece is attached to the under side of the moving head of the testing machine. Upon the platform shall be fastened two blocks having machined top sur faces and polished corners of radius, R, of 1.00 inch. These blocks shall be separated by a distance, W, equal to

*For ship-plate steel (58000-68000 lb. per sq. in. tensile strength), it is "The test specimen shall bend cold through 180° without cracking on the outside of the bent portion, as follows: For material ¾ in. or under in thickness around a pin the diameter of which is equal to the thickness of the specimen; for material over ¾ in. to and including 1¼ in. in thickness, around a pin the diameter of which is equal to 1½ times the thickness of the specimen; and for material over 1¼ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen."

D plus 2 T plus 1/8 inch. A lubricant of lard oil and graphite or similar compound shall be used on these surfaces.

Two specimens shall be tested. The load shall be applied at the center of the weld—in one specimen to the open side of the "V" and in the other specimen to the closed side.

The rate of application of the load shall not exceed that

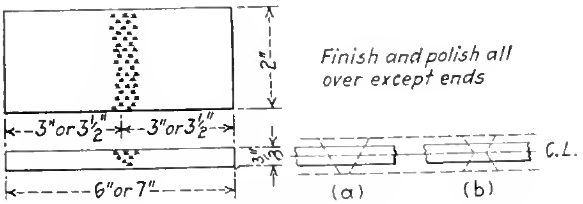


Fig. 7.—Method of Preparing Specimens for Upton-Lewis Machine

at which the beam can be kept balanced at all times or a maximum of 2 inches per minute.

The angle through which the specimen is bent may be measured by any convenient method. The following method is described as a matter of information.

A piece of paper is held firmly against the edge of the specimen when it is in place on the testing fixture and a line drawn on the paper along a corner of the specimen, thus outlining the shape of the specimen so far as bending is concerned. A line is drawn before loading and after

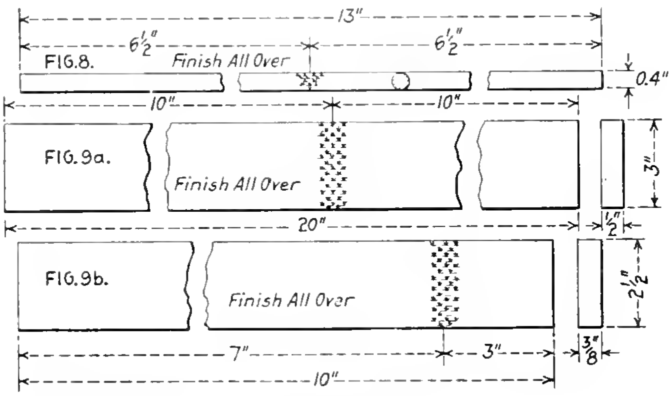


Fig. 8.—Specimen Prepared for Testing in the Farmer Machine

Fig. 9a.—Type of Specimen Used in the Strohmenger Reverse Torsional Machine

Fig. 9b.—The Strohmenger Bending and Impact Machine Used Specimen with Weld Just Outside of Clamp

failure occurs. The change in the angle in the two lines as determined with a draftsman's protractor is the angle through which the specimen had been bent at failure. See Fig. 14.

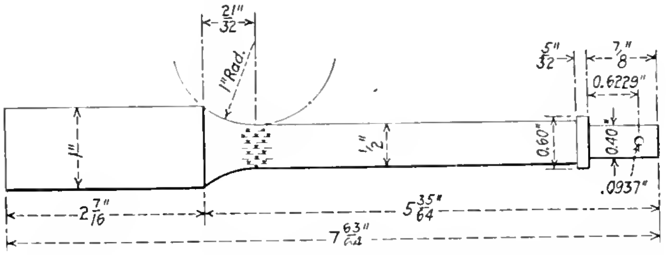


Fig. 10.—Type of Specimen Used in the White-Souther Machine

C. Test Results to be Recorded

(a) The total angle through which the specimen has been bent when the first crack appears upon the convex surface (that is, the sum of the angles through which the two halves were bent). To be measured without removing the load.*

(b) The load on the specimen at which the first crack occurs.

7. *Fatigue Tests, Base Metal, Weld Metal and Weld.*

There is no generally accepted unit or standard of comparison for fatigue tests so that the results given by the several machines which have been developed for such tests are not directly comparable. It is not practicable at the present time to recommend the use of any particular type of machine, and consequently test specimens are shown for all of the more common types.

Although in general, the results of fatigue tests are of maximum value only when compared with similar results obtained on the same machine, it is assumed that reference tests will be made on the base metal so that the results of tests on welds and weld metal can also be stated in terms of the results of tests of base metal. It is hoped that this will permit direct comparisons between tests made with different types of machines.

A. Machines and Test Specimens

(a) *General.* For tests of weld metal it will be necessary to form a suitable bar in a box similar to Fig. 3 and having the proper dimensions.

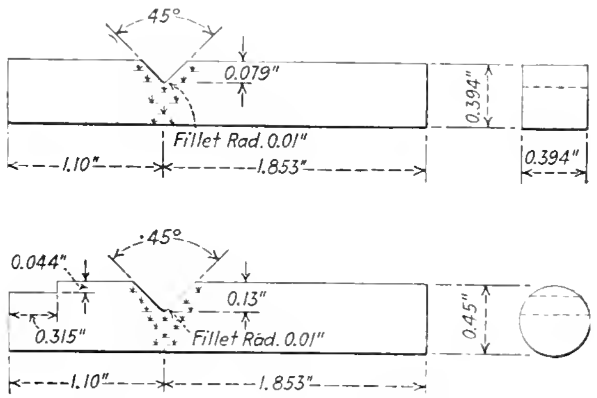


Fig. 11.—Square and Round Specimens

Fatigue test specimens should in general be machined all over (except the ends) and the surface carefully polished (preferably with the polishing marks parallel to the longest axis of the specimen). No. 1 Manning emery

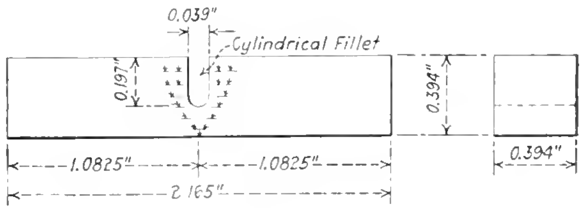


Fig. 12.—Square Specimen for Cylindrical Fillet

cloth or paper or its equivalent will produce a satisfactory surface.

Provided the specimens are prepared from a test weld or other material of greater thickness than the specimen, an equal amount shall be removed from both sides so that

* Note—An electric light and mirror will assist in observing this surface as indicated in Fig. 6b.

the specimen shall represent the material at the middle as indicated at a and b, Fig. 7.

(b) *Upton-Lewis Improved Machine.* This machine puts a bending load on the specimen which is reversed during each revolution of the machine. Specimen shown

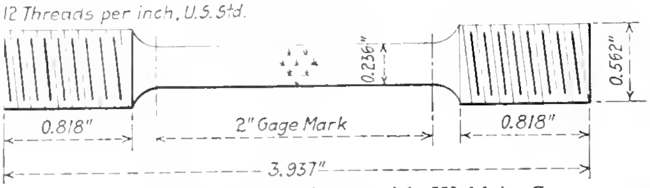


Fig. 13.—Threaded Specimen with Weld in Center

in Fig. 7. The distance between the jaws of the machine shall be ½ inch. If the specimen is a weld specimen, the jaws shall be equidistant from the center of the weld metal.

(c) *Farmer Machine.* This machine was designed specially for testing weld specimens. It tests the specimen as a simple rotating beam with free supports at the ends and two equal loads on a section at the middle (Fig. 8).

(d) *Strohmenger Reverse Torsional Machine.* Comparative results only can be obtained, as there is no means

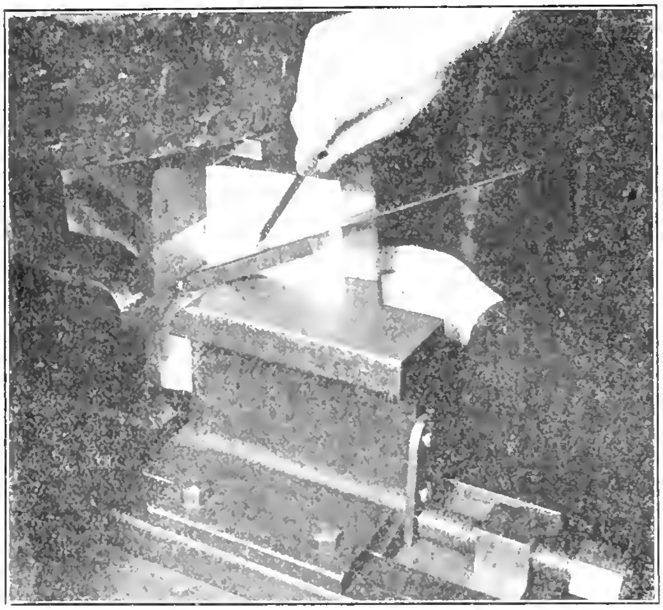


Fig. 14.—Arrangement for Recording the Angle Through which the Specimen Is Bent Before Failure

of determining the stress. This machine loads the specimen in torsion, which is reversed for each revolution of the machine. Specimen shown in Fig. 9a.

(e) *Strohmenger Bending and Impact Machine.* Comparative results only. The machine strikes the specimen, which is held as a cantilever beam, bends it and releases it. This operation is repeated upon the other side of the machine (Fig. 9b).

(f) *Moore Machine.* This machine was designed for the Bureau of Standards for testing large size specimens of joints, both welded and riveted.

Specimens.—Any thickness not exceeding about 1 inch, with 8 inches, length 32 inches. If the specimen is a weld specimen, the weld metal shall be at the middle of the length of the specimen.

(g) *White-Souther Machine.* This machine loads each end of a rotating specimen as a cantilever beam. It is then rotated. The specimen is shown in Fig. 10.

B. TEST RESULTS TO BE RECORDED

(a) Number of cycles of the stress to cause failure

(b) The stress developed in the specimen (if possible).

Burning Refuse in Heating-Boiler Furnaces

THE householder finds it easy and convenient to dispose of combustible refuse by burning it in the furnace of his heating boiler, but disastrous results often follow. There is danger not only of overheating or burning the metal if the boiler is empty, but also of producing severe

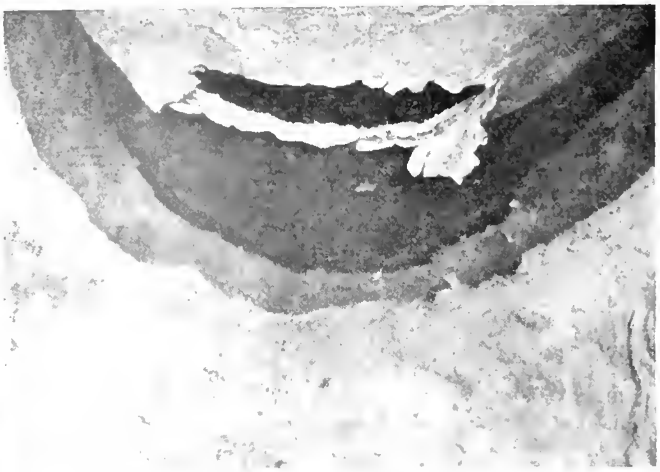


Fig. 1.—Burned Fire Sheet of a Horizontal Tubular Boiler

expansion and contraction strains (particularly in cast-iron sectional boilers), no matter whether the boiler is empty or has water in it.

Fig. 1 shows the fire sheet of a horizontal tubular boiler in which there is a hole measuring approximately 18 inches by 24 inches. Waste paper and other refuse matter had been burned in the furnace while the boiler was empty. The damage to the boiler was discovered by an inspector who had been asked to make an inspection before the boiler was put in operation. It will be seen that extensive repairs were needed before the boiler could be used.

Fig. 2 shows damage of a similar character in connection with a watertube heating boiler. In this case the boiler was fired up without any water in it, and it was necessary to install a complete set of new tubes.

Never build a fire under an empty boiler; and it is safer to avoid burning refuse in a boiler furnace at any time except when the boiler is in operation. A surprisingly small amount of fuel may produce sufficient heat to cause serious damage, if the boiler is cold and the heat is applied to it suddenly and locally.—*The Travelers Standard.*

Fig. 2.—Damage Caused by Firing Up an Empty Watertube Boiler

Water Treatment on the St. Paul

IN many places the available water supply is very unsatisfactory for use in boilers. The country traversed by the Chicago, Milwaukee & St. Paul east of the Missouri river in South Dakota presents conditions which may be taken as typical of those under which railroads are frequently obliged to operate.

The few streams run slowly through lands so rich in the soluble salts of calcium and magnesium that the river waters are always hard, and the more the rainfall on adjoining lands and the higher the rivers, the harder the water. Because of the scarcity at or near the surface, most railroad supplies are derived from drilled wells, which vary in depth from 50 feet to 1,500 feet and in which the character of the water varies as widely. In the ground are two layers of sandstone whose horizontal cracks furnish the supply, the water from the lower sandstone being very hard (80 to 90 grains per gallon) and carrying also 20 to 60 grains of sodium sulphate or chloride, while the water from the upper sandstone so closely resembles the lower water after softening that it is presumed to be the same water softened in the ground; that is, by zeolitic action. This soft water is available, however, only in sections near the Missouri river.

The problem through a considerable district was one of securing an increased amount of water, as bad as it was, and of accomplishing something in the way of improving it. Additional wells were drilled at a number of points and the use of boiler compounds was resorted to. Results were not sufficiently satisfactory and it was decided to install a series of water treating plants. Seventeen plants are now in operation and they cover every water station in a district which includes about 400 miles of line.

The new plants are continuous in operation. All of the main line plants with the exception of those at two points, are designed to treat 15,000 gallons of water per hour continuously and consist each of a hard water pump; a 40-minute reaction tank within which the mixture of hard water and the necessary chemicals (all fed in continuous streams) is slowly stirred by mechanical means; a three-hour settling tank; a treated water pump which delivers to the track tank, and a chemical storage room; all strongly housed and heated.

The plant at Scotland, S. D., is typical of the main line plants. Everything is of wood except the machinery and pipe. The drilled well, 12 inches by 168 feet, under the pump room furnished water to a double-stroke deep-well pump which delivers it through a 6-inch pipe to the water wheel which does the stirring. The water, after passing the wheel, flows to the bottom of the mixing tank where, as it rises, it meets in succession the continuous streams of milk-of-lime, sodium carbonate and ferrous sulphate solutions.

Hydrated lime is used in water treating to extract the carbonic acid, which brings about the precipitation of the scale-making limestone carbonates down to three grains per gallon or less. Sodium carbonate (soda ash) is used to replace completely the scale-making limestone sulphates by non-scaling sodium sulphate. Ferrous sulphate (green sulphate of iron) is used for the treatment of the last three grains of calcium carbonate so that it will not clog the injector or branch-pipe; this, by converting half of the calcium carbonate into calcium sulphate.

In these plants, these reagents are all fed by regulated streams of water from the pipe which supplies the water wheel. The milk-of-lime box holds 480 gallons of water for a five-hours' supply (at Scotland 400 pounds) and this is fed continuously by a small stream of water entering at the bottom of the lime box and overflowing near the top through a 2-in. pipe to near the bottom of the mixing tank.

Once every hour, an hour's supply of dry hydrated lime is added to the supply in the box. This method produces an hourly variation in the rate of lime feeding, but the stirring in the mixing tank is so thorough and so prolonged (45 minutes) that only a slight variation is found in the water as it overflows from the top of the mixing tank to the bottom of the settling tank.

The dry soda ash rests on a shelf in the soda box and is fed to the mixing tank by a spray. The supply on the shelf is replenished hourly. The sulphate of iron is fed in solution from its box by a small stream which enters at the bottom and overflows near the top.

The best method of feeding any reagent to a treating plant is determined principally by its solubility in water and in all cases the thinner the solution or mixture the better. The arrangement of feeding devices described above is not theoretically perfect, but has been adopted as the result of experience in handling railroad plants which are frequently miles from a repair shop and are seldom operated by skilled mechanics. The uniformity of results is the best proof of the wisdom of the design and method.

The water, with its chemical reactions practically complete and its precipitate ready to settle, arrives at the bottom of the settling tank and there commences to leave its precipitate as the water slowly rises to overflow through the perforated collecting pipe to the treated water pump in the pump room, whence it is delivered to the track tank.

The settling tank is freed of its accumulated sludge once daily by opening for 30 seconds the valves controlling the system of perforated sludge pipes lying in the bottom of the settling tank. The perforations are in the bottom of the sludge pipes, and the branch pipes are connected to the main pipes by street-ells so that they are close to the floor.

The treating plants were built by company forces at an expenditure of approximately $18,000 for each of the larger plants and $7,000 for the smaller ones. Since their installation boilers have been free from scale and from leaking, and almost free from foaming. Boiler repairs are now almost nothing and during the entire strike period no boiler troubles attributable to water were reported in this district.

Power Press Code and Head and Eye Safety Code Approved by the A. E. S. C.

The frequency of two of the most serious and most common types of industrial accidents should be greatly reduced through the application of two safety codes which have just been approved by the American Engineering Standards Committee. The Safety Code for Power Presses, Foot and Hand Presses, which has been approved as "Tentative American Standard," is the first national safety code on this subject to be prepared in America. The Safety Code for the Protection of Heads and Eyes of Industrial Workers, which has now received the A. E. S. C. approval as "American Standard" had been approved by the committee some time ago as "Recommended American Practice."

The high speed punch or forming press is one of the most dangerous machines in industry. This code consists of two parts—the first part describing standard requirements and the second consisting of a discussion of press hazards and protective methods and devices.

A statement from the National Committee for the Prevention of Blindness calls attention to Dr. Earl B. Fowler's estimate that there are in the United States approximately 15,000 persons who have been blinded by industrial accidents and that this is almost 15 percent of the blind population of the country.

Because of this serious situation the U. S. Bureau of Standards with the cooperation of the War and Navy Departments began in 1918 the preparation of a head and eye safety code. Several years ago this code was submitted for the approval of the American Engineering Standards Committee and it has since then been the subject of investigation, criticism, and revision.

The Inspection and Insurance of Steam Boilers

By R. J. Furr

The objects of boiler insurance and the work of boiler inspection are well known to our readers, but there are many phases of this form of protection not generally understood. The accompanying article outlines the fundamental principles of insurance, the qualifications of inspectors and the details of external and internal inspections.

THE underlying principle of insurance is protection from loss caused by the unexpected, the unusual or the catastrophe. The fact that steam boilers explode unexpectedly and violently makes their insurance desirable. The inspection service given by insurance companies is thorough and most efficient because they make every effort to prevent boiler accidents and the resultant loss in life and property.

The fact that boilers will explode violently makes their inspection necessary, for the operation of a steam boiler plant is dependent on the boilers, and if an accident occurs to the boilers, the whole plant is crippled. Perhaps a few remarks on boiler explosions will serve to illustrate the enormous damage which may be caused by the explosion of steam vessels of this kind.

Underlying Causes for Boiler Explosions

When a boiler explodes, the first question asked is, what caused it. Answers differ widely and sometimes the cause is unknown. However, one of the most satisfactory explanations of the mechanism of a boiler explosion is known as the Colbrum-Clark theory, which briefly is as follows: An initial rupture, sudden rapid reduction in pressure, the formation of a great quantity of steam in the water, hurling the water at the opening, increasing the latter and shattering the boiler; completion of vaporization of the liberated water projecting the parts to distances depending on the violence of the expansion.

Since the explosion of a boiler is likely to result in injury or death to many people, causing mental anguish and physical pain as well as expense to the plant owner because of the destruction of property and stoppage of the works, inspection is a necessity. In many instances the responsibility of the owner is not slight, as he is held responsible by many states and cities if he uses a boiler of poor design or a boiler which is not regularly inspected, or if he is proved guilty of negligence.

Energy Contained in Boiler Under Pressure

There are few, indeed, who realize that an ordinary cylindrical boiler when working under a steam pressure of only 150 pounds is possessed of sufficient explosive energy to project and carry it in a perpendicular direction a distance of about three miles. The damage done by the explosion is due to the energy in the hot water. This energy can easily be calculated, and roughly speaking, in one pound of water at 150 pounds steam pressure there are about 10,500 foot pounds of energy, *i. e.,* sufficient force to raise a weight of one pound to a height of about two miles. For example, the total energy stored in a Lancashire boiler 30 feet long by 8 feet diameter with 150 pounds steam pressure is in the neighborhood of 207,600 foot tons, which is sufficient to raise the whole boiler 12,500 feet or more than two miles.

In a boiler full of water and under pressure of steam at 150 pounds absolute which corresponds approximately to 135 pounds pressure gage, a pound of steam occupies 3.012 cubic feet. If the pressure is reduced to 15 pounds absolute, which is slightly above atmospheric pressure, the pound of steam will occupy 26.27 cubic feet, an increase in volume of 873 percent. Water which is generating steam at 150 pounds absolute has a temperature of 358.5 degrees F.; at 15 pounds absolute it has a temperature of 213 degrees.

If the pressure on a boiler steaming at 150 pounds is suddenly reduced to that of the atmosphere the expanding steam will increase in volume many times and the heat stored in the water contained in the boiler will evaporate the water into steam as soon as the pressure is reduced. This is the reason that the initial rupture of a boiler may be comparatively small, but the following explosion may be violent. In other words, the tension maintained on the surfaces of the water in the boiler by 150 pounds' pressure prevents the water from boiling until it has reached a temperature of 358.5 degrees, but when the pressure is reduced to that of the atmosphere the water boils at a temperature of 145 degrees less, which causes the water immediately to flash into steam.

A few reasons for boiler failure:

(1) Defective design.

(2) Ignorance as to the amount of pressure the boiler will stand.

(3) Reduction in strength by deterioration.

(4) Defective workmanship and material.

(5) Mismanagement.

(6) Overheating of plates caused by low water, accumulation of scale, oil, mud or other deposit preventing the water gaining access to the plates.

(7) Defective safety appliances.

(8) Obstruction between safety valve and boiler.

No one believes that inspection will absolutely prevent all explosions, but rigid inspection will discover defects that might prevent an explosion. Anyone who has seen torn shell plates, sheared rivets, scattered tubes and wrecked buildings after a boiler explosion is convinced that inspection is necessary. As a profession, boiler inspection may be developed to a high degree.

Attitude of Boiler Users to Inspections

Too often there is an indifferent attitude among boiler owners and operators toward the value of good boiler inspection, resulting in no inspection whatsoever. Again, there is a lack of hearty cooperation on the part of the owner or the engineer when insured and sometimes manifests itself in deliberate antagonism. The cause may be the disinclination to incur additional expense, and because of this indifference more lives will be lost if all states do not make laws requiring standard boiler designs, compulsory inspection and licensing of engineers and firemen.

Success in boiler inspection work is contingent on the inspector's ability to find defective conditions, to point them out to the assured in a diplomatic and forceful manner which will give the assured a clear understanding of the condition and convince him that the recommended repairs are necessary to prolong the life of the boilers, to reduce the operating costs and to become general instructor to the plant operatives, particularly in mechanical matters.

Frequently, one hears the expression, Mr. ———, who is an engineer or boiler maker, is sure to know all about boilers. In my opinion, based on considerable experience, engineers and boiler makers as a rule are not capable of judging the condition and strength of boilers until after some time with an experienced inspector and a careful study of the boiler code makes them competent to measure up certain types of boilers (those with which he has come in contact through instruction) and determine the safe working pressure. Certain it is he will be unable to locate all defective conditions, for careful thought and considerable experience is required before he acquires ability to analyze situations and to determine when conditions present a serious hazard. Of course, all boiler makers and engineers do not come under this head as far as inspections are concerned, but certain it is that they are not necessarily qualified for this particular work because of the lack of the theoretical knowledge essential in the design of boilers and judgment required in respect to repairs.

The boiler inspector must know boilers thoroughly, so well in fact that he feels certain that his recommendations or demands are absolutely right. On the other hand, he must not be overbearing, but always open to conviction, and be broad-minded enough to admit error if he finds he has taken an incorrect view because he did not possess a knowledge of all the facts. He must be a close student of human nature and know just how to approach the owner, engineer or those who are in charge in order to get the desired results. The inspector should be, if possible, well informed in different branches of engineering, also topics of the day, so that he may be in position to discuss questions other than those pertaining to boiler inspection, because as a rule a great number of people with whom he has to cooperate know little or nothing regarding boilers, and in order that they can form an opinion of his ability they usually endeavor to discuss some question with which they are familiar. If he shows that he is informed on this and other subjects it is usually conceded that he is reasonably well informed in his profession.

The inspector should be robust, for inspecting boilers is no child's play, but is one of the most fatiguing of occupations. The inspector is often required to undergo severe temperature changes. However, the inspection of boilers is a very healthful occupation because of the exercise and outdoor nature of the work.

Value of Reports

The inspector should be capable of expressing himself well both orally and in writing, for only by properly presenting the findings of his inspection to the plant owner can he hope to impress him with the value of his work. The report must also be clear to the heads of his department, so they can properly handle the case. Boiler inspection is a great deal more than reporting the absence of approved blow-off valves, feed water connections, etc. A boiler with the water column set low, the feed water introduced through the blow-off pipe, and an ancient globe valve on the blow-off line may be a better insurance risk because of the care and attention it receives, than a boiler which is provided with approved appurtenances.

The fact that the blow-off pipe of a boiler is not properly protected is not a sufficient reason to refuse to insure the boiler, but if the blow-off pipe is properly protected but wasted away from corrosion caused by accumulations of wet ashes until it may be dented by a light blow of the hammer, the situation is serious and requires immediate action. The man who reports the unprotected blow-off pipe is following the rule. The man who digs down through the ashes to the horizontal section of the pipe and gives it a good hammer test is the better of the two, he is safe at least; but the man who tests the pipe and then convinces the assured that he should install a new blow-off pipe and properly protect the pipe after it is installed, is a real inspector.

Classes of Inspections

Boiler inspections are divided into two general classes usually termed external and internal. The external is made without any previous notice to the assured and the inspector's duties are such that the operation of the plant is not interfered with, providing everything is found in order. The internal inspection cannot be made until the boiler is idle and the manhole and handhole plates are removed as well as otherwise prepared for examination. This requires a notice sent the assured some few days in advance of the time set for the inspection. I will first describe the internal inspection and I can assure the readers that finding the boiler is sometimes no small part of the inspector's task. This condition is usually due to records that are in error regarding the location which are furnished him.

On arriving at the plant the inspector usually meets the engineer or other attendants. At this meeting he should endeavor to size up his men because the plant employee can make his task difficult or otherwise, he can also be of inestimable value in giving information regarding the operating conditions which the inspector could not obtain in any other way.

Safety Provisions

Adequate means of exit should be provided from the boiler room. This will often prevent a minor accident resulting in the injury of an employee, an expense to the assured or insuring company which could have been prevented. The blow-off connection is a source of such accidents, as the valve is frequently so placed that the person operating it is in a closely confined place with the piping so arranged that a break at any point during the act of blowing off is likely to cut off all means of escape. It is the inspector's duty to recommend the necessary changes to prevent such an occurrence. The steam and water piping as a whole should be carefully examined to see that the proper supports and valves are provided and the arrangement is such that it will not lead to accidents or dangerous conditions of operation. The feed appliances and piping between them and the boilers should be inspected as to their condition and capacity, so that the boilers may at all times be supplied with enough water to meet their maximum capacity.

The steam pipe should be so arranged that no pockets will be formed to trap the condensation, and it should also be so connected that contraction and expansion can take place without undue strain on any of the parts. Many accidents have resulted owing to a lack of precaution in suitably arranging the steam piping. Examination must be made of the attachments and connections for determining the water level, as water columns are frequently found set so low that the safety of the boiler is endangered, and the drain or blow-off connection from the water column is examined to see that its size is ample. The connection from the steam space of the boiler to the top of the water column is inspected to see that there are no connections on this pipe that are required to furnish steam for any other apparatus or that water can be trapped in the pipe. The lower column line to the water space is also examined to see that provision has been made by which the pipe can be examined to determine if it is clear at regular wash-out periods.

If either of the lines is equipped with stop valves they must be of approved type and sealed open, as these conditions will render the indications of the water level inaccurate. The position of the steam gage is noted to see if it is in the correct location as it is frequently so connected to a boiler that the steam comes in direct contact with the spring or it is fastened so as to be exposed to heat from some part of the boiler or smoke flue, either of which conditions renders it inaccurate. The next and most important attachment to be examined is the safety valve, which deserves the closest scrutiny to determine its condition. If the safety valve is equipped with an escape pipe, the inspector must see that it is of ample size, void of valves or other attachments, properly drained and well supported to prevent undue strain on the valve.

The method of boiler suspension and the ability of the supports to safely carry the load, require complete data on columns, supporting members, hangers, etc. The determination as to whether each support is carrying its proper proportion of the load for adequate boiler support is as necessary to its safety as the strength in other respects.

Internal Inspection

The inspector, after writing the answers asked on his data slip regarding the various parts examined so far, then enters the top manhole with a light, hammer, rule, calipers and depth gage. Since this inspection is assumed to be the first one made of the boiler under question, he must obtain the necessary data for calculating the strength. The distance between the shell and the top of the tubes must be known in order to correctly estimate the amount of bracing required. The number, spacing, and size of the braces at their least cross section on each head must be obtained, together with the type and if they are welded or not. He must know the number and size of rivets attaching the braces to both head and shell, so that the weakest element in the construction can be taken into account in calculating the strength. The thickness of the heads must be ascertained in order to estimate the strength of any unstayed surfaces, calculate the area to be braced and to judge whether a suitable bearing surface has been supplied against which the tubes were expanded. The bands must be carefully examined around the flange for cracks or other defects.

The design of the joint, together with the size and pitch of the rivets, must be obtained so that its strength relative to that of the solid plate may be determined. The size of the rivets is usually judged from the dimensions of their heads and the thickness of the shell. The shell thickness must be known and usually can be measured by means of a depth gage applied along the edges of the plate or at an opening in the shell. The length of the tubes is also obtained. If there is a dome, the details regarding the bracing of the head if flat must be known. If concave or convex the radius of the bump together with its thickness must be known. The diameter, thickness of the sheet, type of joint, together with the size and pitch of the rivets, also the manner of its connection to the shell, must be secured as well as the dimension of the reinforcement around the opening from the boiler to the dome, should this opening be large.

The inspector next carefully examines the condition of the surfaces. The shell may show evidences of pitting, especially just below the water line. The tubes may be pitted or thin from general corrosion. The braces may be weakened by deterioration or they may be loose due to improper fitting or strain. Their soundness may be determined by striking them with the hammer as well as by visual inspection. The shell is carefully sounded to determine if there are indications of cracks or laminations in the material. It is well to sound many of the rivets for tightness. The condition of the upper portion of the boiler as regards to scale, oil or other deposits is noted, for in parts of the country it is not uncommon to find the spaces between the tube against the rear head completely stopped for a considerable distance. Conditions of this kind are likely to lead to serious trouble if not explosions. Oil, regardless of the amount in a boiler, is a serious matter. There is no substance likely to reach the interior of such a vessel that can produce an effect of such seriousness as oil. All openings to outside attachments or connections are examined to see if free, as many serious accidents have been caused by stoppage of the water column connection. When the connections are supplied with a pipe screwed into a part of the boiler or flange riveted to the shell, the inspector must be certain that the screwed joint has been fully made.

Upon coming out of the boiler the inspector places the data obtained on a data slip. The next point to be examined is the front head relative to corrosion due to improper laying up the boiler, especially if it is fitted with a stack connected directly to the extension sheet, for under these conditions rain may come down the stack during idle periods and the sulphur deposits on the head combined with moisture cause extremely rapid corrosion. Careful examination of the surface to locate any brands or stamps placed on the sheets by the manufacturer is necessary for correct records.

Condition of tube ends and beads if thin or broken, the number of tubes, their spacing and distance between bottom of tube and shell are necessary information to correctly estimate the bracing required. If a manhole is supplied communicating with this part of the structure, he enters it and the usual points to be given attention are soundness of bracing the condition of the shell from corrosion or other defects, the heads and tubes, and to note the amount and kind of scale attached to the surfaces. The blow-off pipe is examined for its proper make-up. If there is no manhole below the tubes, the information just specified is obtained as nearly correct as possible in the upper part of the boiler and also through the hand holes which are usually supplied in the front and rear heads.

Inspecting Combustion Chambers

The inspector next enters the combustion chamber noting the condition and position of the covering, as the arches generally used at this point are frequently located so high as to cause overheating of the head above the water line. The fusible plug which is located in the rear head must be examined to see that the metal is in good condition. The blow-off pipe must be examined and tested to see if it is sound and free at the bottom. The method of protection and freedom where it passes through the setting wall is also essential to safety. He should carefully observe the kind of fitting and pipe used, for in a number of instances low pressure material is used. The rear tube ends must be examined for leakage, bad beading and corrosion. If defects of this kind are disclosed, the cause must be determined and such recommendations made to eliminate the condition. He next observes the condition of the sheets and seams. If rivets leak, the outside of the boiler usually reveals this fact. Leakage of girth seams can be caused in many ways. If leaking is from scale or other deposits, inspection of the interior already made will generally reveal the cause.

Fire cracks are another source of leakage. These can be overcome quite frequently by driving new rivets, chipping and recalking the seams or by removing the rivets, welding the cracks, reaming the holes true and re-driving the rivets.

The location, size and shape of the bridge-wall which forms the rear limit of the grate surface is often the cause or contributes to leakage at girth seams, for in many instances it impinges the flame directly against the seam. Improper boiler supports are also contributing causes. Feeding in the bottom of the boiler through the blow-off connection is another fruitful source of trouble.

The inspector must make a close examination for evidences of leaks coming from the vicinity of longitudinal seams, as any such leak is likely to prove a hidden crack. This defect has been responsible for some of the worst explosions known to steam boilers, and no leak at a longitudinal seam should be considered harmless until so proven. Condition of the setting walls should be carefully considered, particularly with respect to their ability to properly support the boiler. After measuring the grate in order to estimate the number of square feet of grate area, condition of fire door arches and fire linings observed and proper recommendations made, the inspector is ready to test and if necessary to correct the steam gage. Then the inspection is completed.

After the inspection, a discussion with the engineer regard-

(Continued on page 22)

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The secretary of the Master Boiler Makers' Association has announced that the association will hold its annual convention this year at Hotel Tuller, Detroit, Mich., beginning Tuesday, May 22, and closing at noon Friday, May 25. Ample provision will be made for exhibit space. Additional details of the convention will be given later.

The constant inspection of the materials employed and the workmanship entering into the construction of boilers is vitally important to their subsequent efficiency and safety in service. On the subject of new boiler construction the American Boiler Manufacturers' Association has become extremely interested in developing shop standards of inspection for the member companies that will insure the best construction and uniformity in the field of horizontal boiler fabrication.

In accordance with the sentiment expressed in the preliminary discussion of the subject of inspection held at the annual meeting of the American Boiler Manufacturers' Association in June, 1922, a special committee was appointed with L. E. Connelly as chairman to formulate a suitable set of rules for inspection. This committee will make a complete report on the subject at the winter meeting of the association to be held at Hotel Astor, New York, February 12. The subject is one which demands close study and every member should attend the meeting with the intention of entering fully into the discussion and of offering any recommendations that will help the committee in its work.

The subject of horsepower rating of boilers, which has also been investigated by a special committee will be reported upon and discussed. Other reports will be presented on the work of the Uniform Boiler Law Society and the recent progress of the National Board of Boiler and Pressure Vessel Inspectors.

Economy is the first consideration of present and future steam locomotive design. Every item of equipment and every modification in design tending to promote the operating efficiency merits careful study. The latest development in design offering a wide range of possibilities is the method of mechanical drafting of locomotives proposed by H. C. Coppus in a paper read at the annual meeting of the American Society of Mechanical Engineers, and abstracted elsewhere in this issue. The fact that existing locomotives may be equipped with the induced draft fans described with only slight structural modifications and the exhaust steam effectively applied in promoting the overall efficiency immediately makes the suggestion a practical one.

The physical difficulties of securing a fan with sufficient capacity to work economically and, at the same time, small enough to be applied to a locomotive have apparently been overcome in the design described. Some of the direct advantages expected from its use are the reduction of back pressure on the cylinders and a degree of flexibility in drafting not possible with the exhaust nozzle. The constant draft of air through the fuel bed will also tend towards more uniform and complete combustion. Another feature tending towards economy in operation and maintenance is the availability of exhaust steam for use in feed water heaters. The saving in fuel and water from this source and the incidental decrease in boiler repairs, especially in bad water districts are factors to be considered. In addition to feed water heaters, condensers can be used which will make possible the conservation of from 25 to 95 percent of all the feed water carried by the locomotive, depending upon weather conditions and the like.

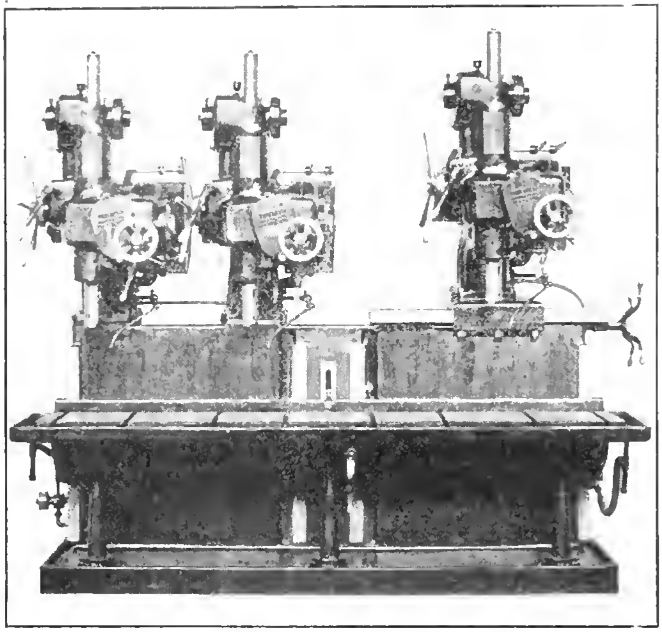
Until locomotives equipped with the system of mechanical draft and economizers outlined have been exhaustively tested in service, it is not possible to determine how wide their subsequent application will be. The discussion on the paper, however, indicated that the subject is of great interest to the mechanical engineers and locomotive designers of the railroads and will undoubtedly be applied directly within a few months by roads acting individually or as a group.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Special Gang Drill with One Moving Head

A special gang drill has been developed recently with longitudinal movement for the right-hand spindle, as shown in the illustration. A four spindle column is used and



Colburn Heavy Duty Multiple Drill Press with Horizontal Adjustment for One Head

regular four spindle table. The two left-hand heads are permanently placed on the column and have a fixed center distance. Head No. 3 is mounted on a plate having finished ways, this plate being attached to the column.

The third head has a horizontal adjustment of 27 inches and is moved by means of a screw and capstan handle. Provision is made for clamping the head securely in any desired position. The minimum center distance between the second spindle and the adjustable spindle is 27 inches. The maximum distance is 54 inches. The minimum distance between the extreme left-hand head and the adjustable head is 54 inches and the maximum distance is 81 inches. Thus the total range between spindle centers is 27 to 81 inches. Instead of having the finished ways extending only half the length of the column they can be lengthened and extend under the second spindle if desired. A fourth head can also be mounted on the finished ways so as to make a regular four-spindle machine with 27-inch center distances between the spindles. The machine illustrated is a Colburn No. 4 drill press, but the smaller No. 2 size or larger No. 6 size can be arranged in a similar manner.

The driving and feed gears of this drill press are mounted inside of each head and run in oil. The gears are made from chrome nickel steel, hardened and heat treated. The shafts are of large diameter and mounted on ball bearings. Automatic trip is provided. The spindles are double splined to equalize the strain and each spindle has a drilling capacity of 2 inches in solid steel. The distance between the center of the spindle and the face of the column is 12½ inches. The machine is, therefore, rated at 24-inch swing. Supporting brackets are provided under the center and ends of the table. The column and table are heavily ribbed, the table having a three-point bearing in the column.

This multiple drill press is said to have great power, stiffness and rigidity and is one of the many types of heavy duty drills built by the Colburn Machine Tool Plant of the Consolidated Machine Tool Corporation of America. The main offices of this company are in New York City.

Simplicity Features New Valve Design

A new type valve, known as the "Flatplug" valve, is being manufactured by the Everlasting Valve Company, Jersey City, N. J., and distributed by the Scully Steel and Iron Company, Chicago, Ill. The valve includes all the more important features of the "Everlasting" type and, in addition, has advantages not incorporated in former types.

The valve seat, which is rectangular in shape, fits into the bottom bonnet on a circular gasket joint. It is held in place here, as may be seen from the accompanying illustration, by the pressure and a stiff spring. The disk, which is cup-shaped, has a sliding contact with the seat at all times. The disk is also held to the seat by the same spring.

In the view of the valve in the left of the illustration the fluid is shown flowing past the cup into the uncovered openings in the seat and so to the outlet. The second view shows the valve in the closed position.

In assembling, the seat is merely pushed into place by hand, no screw threads or other form of fastening being necessary. When taking the valve apart, the seat is removed by pulling it out of the body without the use of tools. When the valve is in its normal position, or on either side or end,

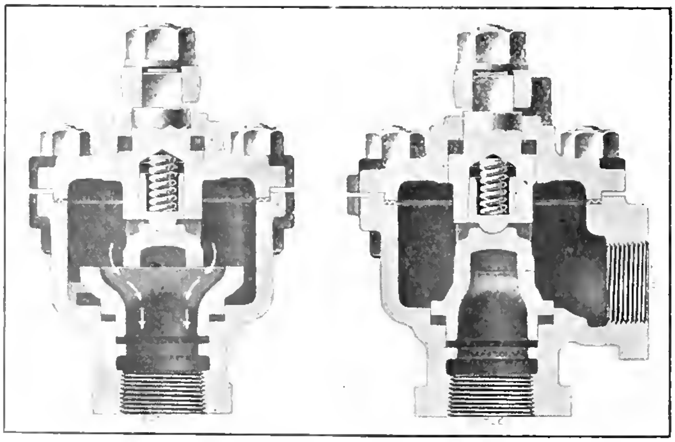


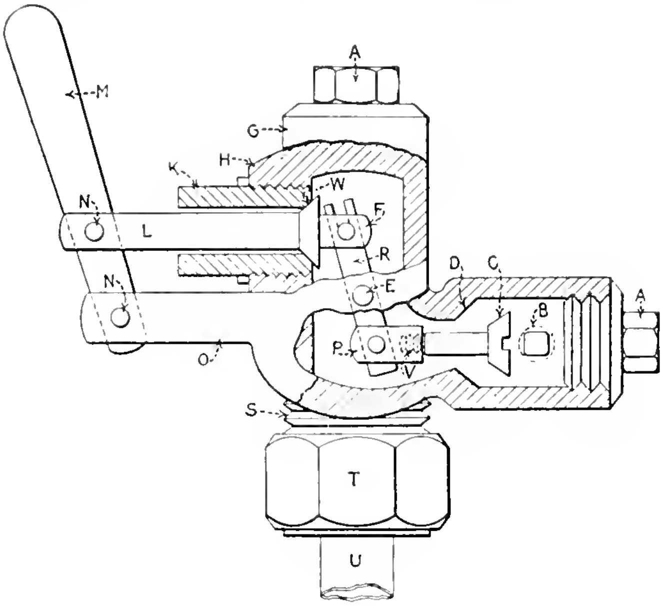
Fig. 1—Valve Open, Fluid Passing Into Uncovered Openings in Seat (left). Fig. 2—Valve in Closed Position

the seat will not fall from place; for when assembled it is held in place by the disk and spring.

In order to make repairs, it is only necessary to remove the top bonnet and all parts are readily accessible. New parts for replacement may be installed without removing the valve from the line or disturbing the piping.

Locomotive Safety Water Gage Valve

An automatic, safety water gage valve, which has given dependable and satisfactory service for more than five years on stationary boilers, has recently been installed successfully on locomotives by the Mattingly Automatic Valve Company, St. Louis, Mo. The action of this valve is as follows, reference being made to the illustration wherein *C* represents the main valve controlling the passage from



Automatic Water Gage Valve in Open Position

boiler to gage glass. *R* is a link pivoted on pin *E* which extends through from one side of the casing to the other. *R* forms a connection between main valve *C* and auxiliary valve *W* and causes main valve *C* to be moved in the opposite direction to that of auxiliary valve *W*, thus preventing both valves from being seated at the same time. *L* is the auxiliary valve stem, the inner end of which is connected to link *R* by means of a fulcrum and pin which fits in the slotted end of link *R*. Valve stem *L* slides through bushing *K*, the bore in bushing *K* being somewhat larger than the valve stem. This allows a passageway around valve stem *L* which is controlled by auxiliary valve *W*, thus eliminating the necessity of any packing around this stem. To the outer end of auxiliary valve stem *L* is connected a lever *M* called the operating lever, the position of which indicates the position of the main valve *C*. When the lever is leaning outward the main valve *C* is off its seat and when the operating lever is leaning inward it indicates that the main valve *C* is closed.

The construction of the valve casing, as illustrated, provides a boiler connection at right angles to allow for cleaning the interior of the valve and inserting a rod or wire into boiler through plug *B* and lower plug *A*. The portion of casing marked *G* is offset from the portion marked *H* to allow for a glass or metallic water glass end being inserted from the top through the upper plug *A*.

When either the top or the bottom water gage valve is opened, as shown in the illustration, the pressure is admitted around main valve *C* through the gage glass and into the valve at the opposite end of the glass. This pressure quickly equalizes on each side of the main valve *C* and at the same time exerts itself against auxiliary valve *W* and stem *L* forcing them outward until auxiliary valve *W* rests on its seat. In other words, when one valve (either top or bottom) is opened to admit pressure from the boiler, this pressure automatically passes through the gage glass to the other valve and forces it wide open, holding it open. Should either valve be placed in closed position while the other one is open, it will not stay in that position, but will open again. This is due to the pressure acting against the auxiliary valve and stem as above mentioned.

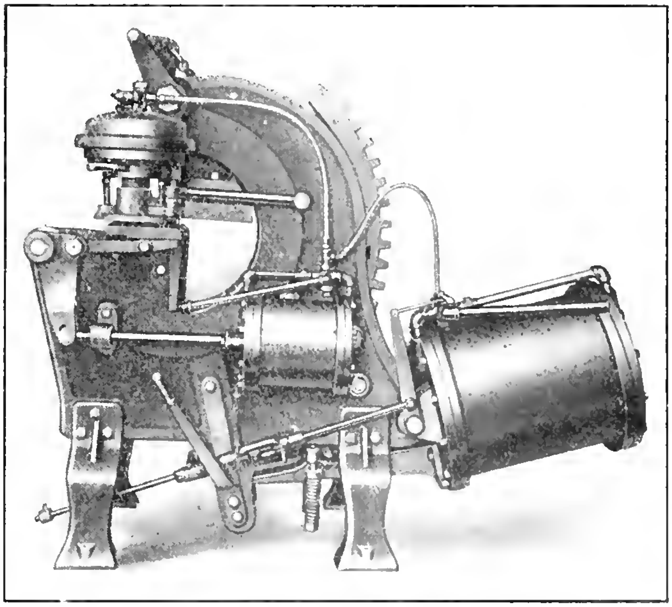
To close the valves while pressure is in the glass, move them both to closed position at the same time. This allows both main valves *C* to close communication between the boiler and glass, at the same time unseating auxiliary valves *W*. This allows the pressure in the glass to escape around auxiliary stem *L* which has no packing around it. Should the gage glass become broken, the pressure will be quickly released off auxiliary valve *W* and the pressure rushing from the boiler will force main valves *C* to their seats instantly stopping the flow of escaping steam and water.

A valuable feature of this valve is the practical impossibility of its sticking or corroding shut. The valve is manually operated and gravity is not depended on to close it. Should dirt or grit become lodged on either valve seat causing a leak, it can usually be dislodged by pushing the operating lever in and letting it fly back.

Heavy Type Pneumatic Flanging Machine

The pressing demand for a pneumatic flanging machine which would successfully flange the heavy plates now being used in the construction of locomotives, prompted the McCabe Manufacturing Company, Lawrence, Mass., to build the heavy type machine shown in the illustration. This machine will flange cold any thickness of boiler plate up to and including ¾ inch. Circular heads, half heads, dished heads, segments of circular heads and straight flanging are flanged cold. Corners varying from 1¼ inch radius to 8 inch radius are flanged in one heat and with one complete stroke of the bending ram.

The new McCabe flanging machine is equipped with a patented pneumatic plate clamp. This clamp eliminates most



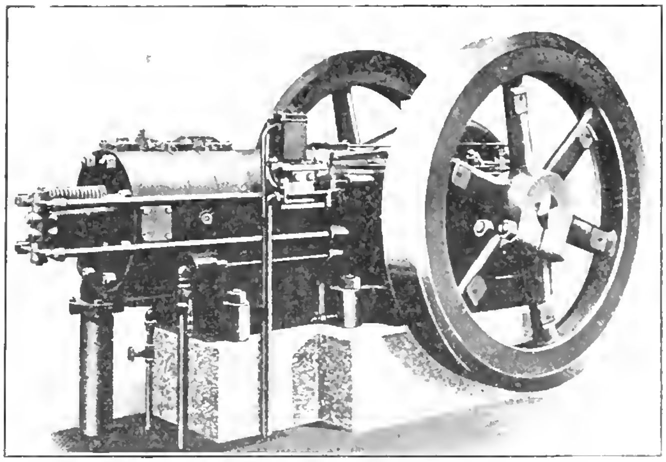
New McCabe Machine Which Flanges ¾-in. Boiler Plate Cold

of the manual labor that was required in the former models. By adopting this new clamping device, the speed of flanging circular work has been increased over 50 percent. The machine is of cast steel construction; is self-contained; requires no foundation; and can be operated anywhere about the shop within range of the air system. All that is required to put the machine into operation is an air hose (100 pounds pressure) and a jib crane for handling the plates.

The advantages claimed for previous models are retained in this machine and include ability to flange similar pieces with uniform accuracy, convenience of moving from one part of the shop to another, or from one job to another, flexibility so as to handle various steel-plate shapes used in locomotives and car repairs, coupled with ease of operation. There are two operating levers, one controlling the pneumatic clamp or locking arrangement and the other controlling the movement of the piston which in turn moves the flanging arm.

Direct-Injection Oil Engine Driven Compressor

The Price horizontal direct-injection oil engine, manufactured by the Ingersoll-Rand Company, New York, employs the Price system of fuel injection which eliminates the need for a three or four-stage 1,000-pound pressure injection air compressor with intercoolers. A pump of single design provides the force for introducing the fuel into the combustion chamber. Two spray nozzles are employed, so arranged that



Ingersoll-Rand 17-inch by 19-inch Type P Oil Engine

their sprays impinge. The head and combustion chamber are shaped so that their surfaces are at all points parallel to the sides of the fuel sprays, thus preventing the fuel fog from coming in contact with a metallic surface where it would collect as drops and result in imperfect combustion.

Important advantages claimed for the Price oil engine are simplicity, sturdy construction, accessibility of parts, fuel economy, lubricating oil economy and completeness of combustion.

Oil Engine Air Compressor Unit

One of the first applications of the Price direct-injection oil engine has been to drive a direct-connected air compressor unit. This unit, of which the 100-horsepower engine forms the prime mover, has the air cylinder in line with the power cylinder but on the opposite side of the crankshaft. For 100 pounds pressure, a two-stage air cylinder is offered. The air intercooler is mounted below the air cylinder and forms a support for it. The general impression given by the unit is one of symmetry, compactness and durability. For air pressures less than 100 pounds, a single stage air cylinder is offered, which is connected to the oil engine frame by a distant piece. For both single and two-stage work, the air cylinders is double acting which has contributed to the exceptional balance of the machine.

In the 50-horsepower size, the air cylinder is vertical and is mounted on top of the engine, immediately above the crank-shaft. By so doing, it has been made possible to mount the unit on a flat car or truck for use in portable work. This construction has not resulted in excessive height, this being kept less than 8½ feet.

The Inspection and Insurance of Steam Boilers

(*Continued from page 18*)

ing the various points revealed by the examination is necessary in order to direct him in making repairs or bettering the operating conditions. Inquiry should be made as to the maximum steam pressure required to properly operate the machinery used in connection with the plant as this should be given consideration in fixing the pressure to be allowed.

Inspecting the Boiler Externally

The external inspection, while not nearly so complete as the internal, is a most important inspection. Operating conditions can be observed and such practices stopped which endanger the boilers. On entering the boiler room the inspector should note the gage pressure carried. The water column must be blown to determine its freedom, this being evident by the speed with which the water returns to its original level as well as the behavior of the water in the gage glass, if the boiler is steaming. The gage cocks should be tried to see if they are free and in good condition.

An examination is next made of the fire surfaces of the boiler and the condition of the furnace walls as far as can be seen from the furnace doors for evidence of leakage, bagging or blistering of the plates. The front flue doors are opened to view the tube ends, which are examined for leakage and their general condition. The rear of the boiler is now visited and the condition of the blow-off valve and connection is determined as far as their operating condition is concerned. If there is a cleaning door in the setting wall, it is quite possible to view the fire surfaces and tube ends.

The top of the boiler is next visited. To make certain the steam pressure at that time, he tries the safety valve. With a safety valve of the spring-loaded type and with the steam pressure not over 20 percent less than the pressure for which the valve is set, a very accurate idea of the pressure at which the safety valve will operate can be obtained by testing its freedom by hand. If it does not appear to be properly adjusted, steam is raised until the valve operates in the ordinary manner or until the increase in pressure positively demonstrates that it is set for a pressure in excess of the limit allowed.

The inspector should discuss the important features of the inspection and plant conditions with the employees, for information of great value both to the assured and insuring company is often obtained in this way.

BUSINESS NOTES

The George Oldham & Son Company, Baltimore, Md., has opened a branch office in the National building, 1404 E. Ninth street, Cleveland, Ohio. This office is in charge of W. W. Davidson and C. M. Hartzell.

The Independent Pneumatic Tool Company, Chicago, announces the appointment of Blake C. Hooper, of the Minnesota Supply Company, Pioneer Building, St. Paul, Minn., as special railroad agent in the northwest for the sale of Thor tools.

The Ingersoll-Rand Company and the A. S. Cameron Steam Pump Works announce the opening of a branch office at 718 Ellicott Square Building, Buffalo, N. Y. This new office is equipped to render full service to those interested in air, gas and ammonia compressors, vacuum pumps, turbo blowers and compressors, condensers, oil and gas engines, pneumatic tools, rock drills, centrifugal and direct-acting pumps and other of the numerous products manufactured by these companies.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

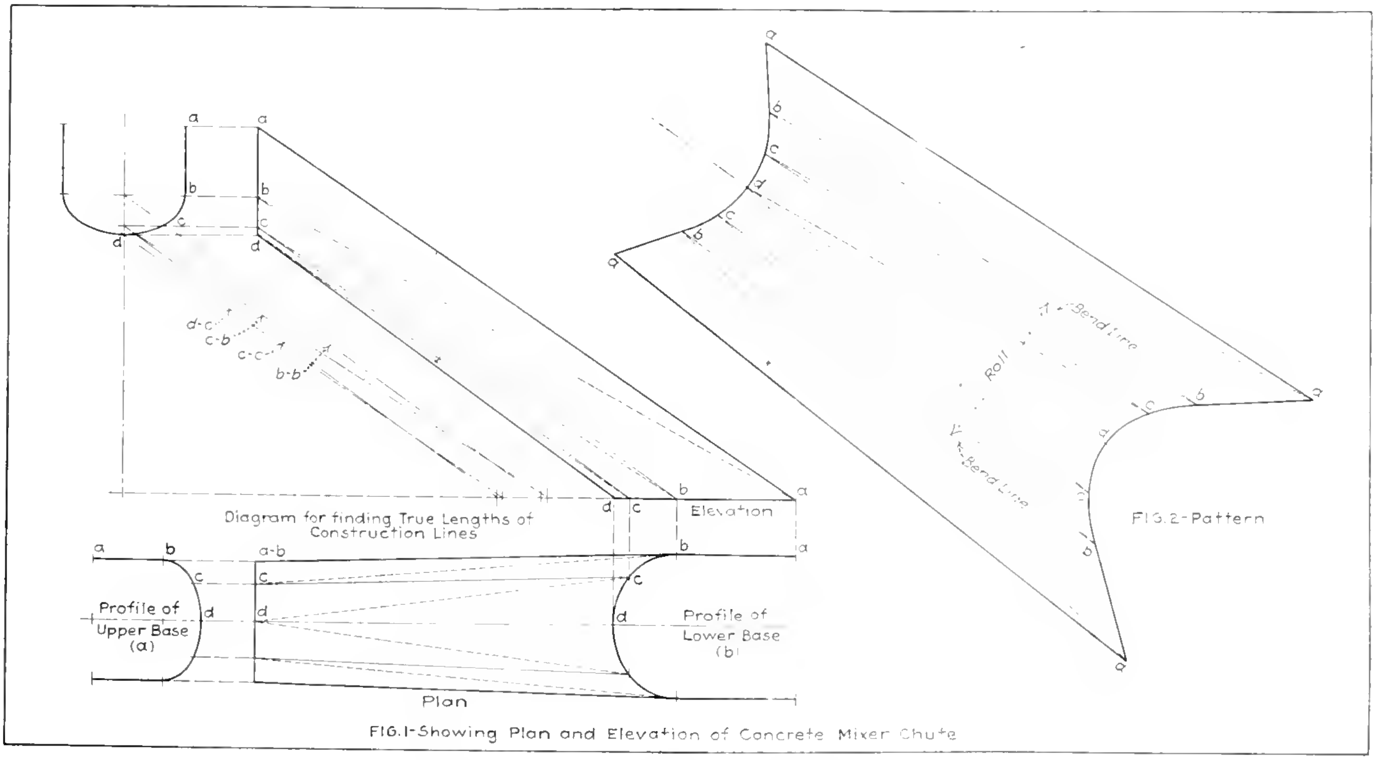
Concrete Mixer Chute

Q.—Please show me how to lay out a concrete mixer chute; also how to lay out bottom of well bucket in two pieces.—J. F. D.

A.—In the solution of this problem it is necessary to show in the plan and elevation, Fig. 1, the relative positions of the openings at each end of the chute, as indicated by the profiles (a) and (b). Then draw in the outline of the sides showing the taper; as *a-a*, *b-b* and *d-d*. Owing to the slight taper in the curved section of the chute along the bottom, it is necessary to find the true lengths of the construction lines for the pattern layout. The curvature of the upper base (a) and lower base (b) are divided into equal divisions as *b-c*, *c-d*, etc., the points of division are then projected to the straight lines *a-d* of the ends of the chute. Construction lines are drawn in from *b-b* and *c-c*, etc., in both the plan and elevation. The true lengths of these lines are determined by drawing right angled triangles, using as the base lines *a-a*, *b-b*, *c-c*, *d-d*, etc., of the plan and the heights as shown projected from the elevation. In the diagram for finding the true lengths all of the true lengths are not indicated, but a sufficient number are shown to give the plan in handling such layouts.

The pattern is developed in Fig. 2, consisting of first drawing the center line *d-d*. The arc lengths *b-c*, *c-d* of the two profiles are used in the stretchout of the ends and the hypotenuses of the diagrams of true lengths, Fig. 1, in developing the contour of the ends. All of the lines are so lettered that it should not be difficult to follow the steps in the layout work.

The bucket problem is not clear to me, as the sketch which accompanied your question did not indicate whether the lip of the conical ends was cut straight or spirally. The construction, Fig. 3, shows the layout with sides cut straight along *a-a* and riveted at the ends. A lap is allowed on one section at the end for riveting the two lip sections together. The pattern development consists of the development of a section of a cone. With a radius equal to *a-b* of the elevation draw an arc *a-b-a* as shown in the pattern. From point *b* in the pattern set off the arc lengths *2-1-a*, *2-3-a* equal to the corresponding arc lengths of the plan, Fig. 3. Draw in



Figs. 1 and 2—Details of Concrete Mixer Chute Layout

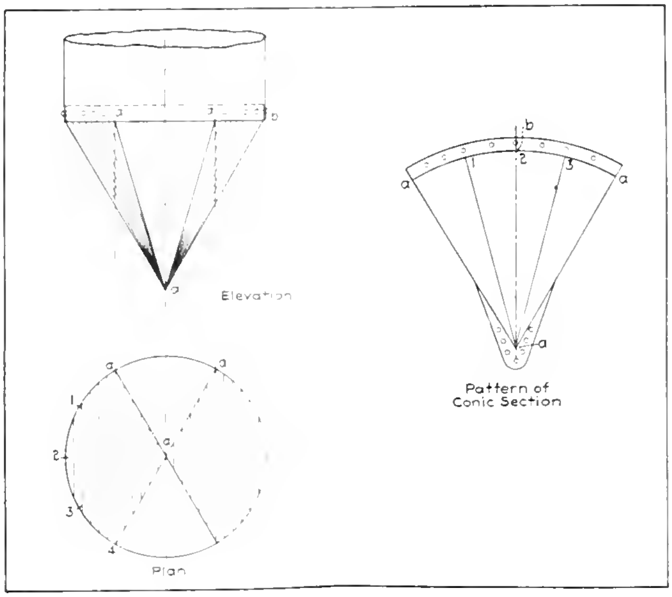


Fig. 3.—Straight Sided Well Bucket Development

the outer radial lines and allow for laps. If this construction does not answer the purpose, advise us and we shall be glad to give any further help required.

Development of Intersection Between a Cone and Cylinder

Q.—Can you supply me with an answer to the following question? The problem is one to find the intersection between a cone and a cylinder. Please make a plan and elevation and show by development how to obtain the curve of intersection between the cylinder and cone; also develop the pattern for the sylinder, cone and opening in the pattern of the cone as required for connecting a 6-inch pipe.—C. LeB.

A.—Sometime ago a complete short cut method was illustrated in these columns for laying off the views and patterns of the cone and cylinder. I would suggest if you do not save each issue of the magazine, that the articles pertaining to the layouts that you are directly interested in be clipped and filed for future reference. The solution given herewith involves principles of projection and each step is given.

A plan and elevation are drawn first about the center lines *x-x* and *y-y*. On the center line of the cylinder draw the circle and divide it into a number of equal parts. From points 1, 2, 3, and 4 draw parallel horizontal lines through the cone which may be considered as cutting planes passed through the cone. The shape of the sections of the cone on these planes are circles, as shown by the circles in the plan view. These circular sections are laid off by projecting points 1_1, 2_1, 3_1, 4_1 from the elevation to the plan on line *y-y*. With point *o* as a center and *o-1*, *o-2*, *o-3* as radii, describe the circles in the plan. The next step is to locate points lying on the miter line as it appears in a plan view, which is done by drawing the horizontal lines from the points on the circular profile (*b*). Where these lines intersect the corresponding circles, as at *b*, *c*, *d*, *e* and *f* fixes the points on the miter. These points are projected to the elevation locating them on the horizontal projectors of the cylinder as a_1, b_1, c_1, d_1, e_1, etc.

In the plan view draw the radial lines through the points *b*, *c*, *d*, *e* and *f* connecting with point *o*. The patterns can now be laid off from the two views. The development of the opening or hole in the pattern of the frustum of the cone is made in Fig. 2. Draw a radial line o'-$a_{,,}$ and set off from *a* the arc lengths $a_{,,}$-$b_{,,}$ $b_{,,}$-$c_{,,}$ $c_{,,}$-$d_{,,}$ as measured on the outer or base circle of the cone, plan view. Connect o', Fig. 2, with the respective points $b_{,,}$-$c_{,,}$-$d_{,,}$, etc., thus locating corresponding radial lines that are intersected by the cylinder. Then points are located by using point o' as a center and drawing arcs from the points *1*, *2*, *3*, *4* to intersect the corresponding radial lines as shown at $a_{,,,}$ $b_{,,,}$ $c_{,,,}$ $d_{,,,}$ $e_{,,,}$ $f_{,,,}$ and $g_{,,,}$. The length of the upper arc of the pattern is equal to the circumference of the base plus the necessary allowance for lap.

In Fig. 3 the layout is given for the cylinder pattern. The length or stretchout *s-s* equals the circumference around the

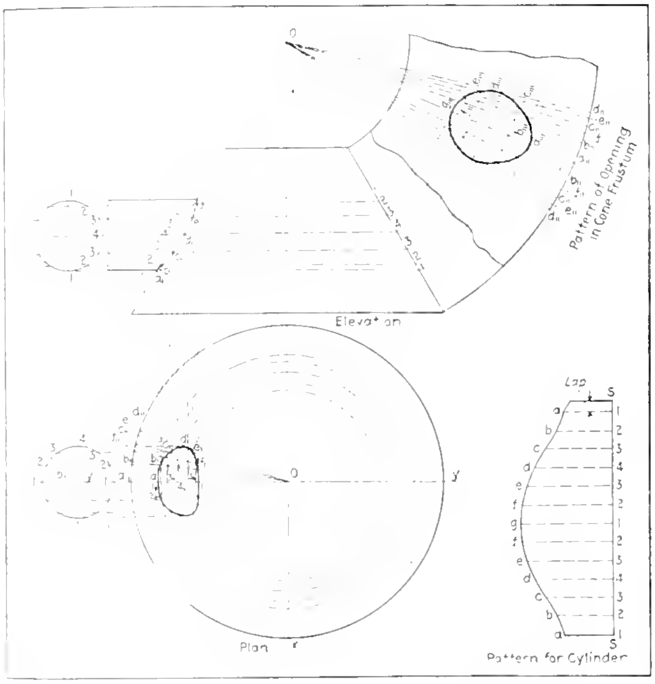


Fig. 1.—Details of Cone and Cylinder Layout

cylinder which distance is divided into the same number of parts as is the cylinder profile. Lengths *1-g*, *2-f*, *3-e*, *4d*, etc., of the pattern equal the corresponding lengths on the cylinder of the elevation, Fig. 1.

Sources of Information on Oxy-Acetylene Welding

Q.—If you know of any one that teaches acetylene welding please let me know as I am anxious to study the proper methods of doing the work. J. M. B.

A.—I do not know of any school teaching the subject of oxy-acetylene welding at the present time. There are several good books on the subject, some of which are published by manufacturers of gas welding equipment, namely: Davis-Bournonville Company, Jersey City, N. J.; Imperial Brass Manufacturing Company, 1200 W. Harrison street, Chicago, Ill.; Air Reduction Company, Inc., 120 Broadway, New York; K-G Welding and Cutting Company, 556 W. 34th street, New York; Linde Air Products Co., New York; Oxweld Acetylene Co., Newark, N. J.

The D. Van Nostrand Company, 8 Warren street, New York, handles the following books on the subject: "Welding and Cutting Metals by Aid of Gases or Electricity," by L. A. Groth; "Modern Methods of Welding," by J. D. Davies. McGraw-Hill Company, 370 Seventh avenue, New York, also has several books on the subject.

I would say that the only way to become proficient in handling the various welding processes is by practice and experience gained in manipulating the torch in producing the various welds. What can be expected from data published on the subject is a knowledge of the nature of materials, gases used, types of joints and methods of procedure in preparing the joints and general instructions along the lines of welding.

Expertness in the work therefore comes from actual experience in handling the equipment and general knowledge gained in the subjects mentioned.

Layout of Oblique Pipe Work

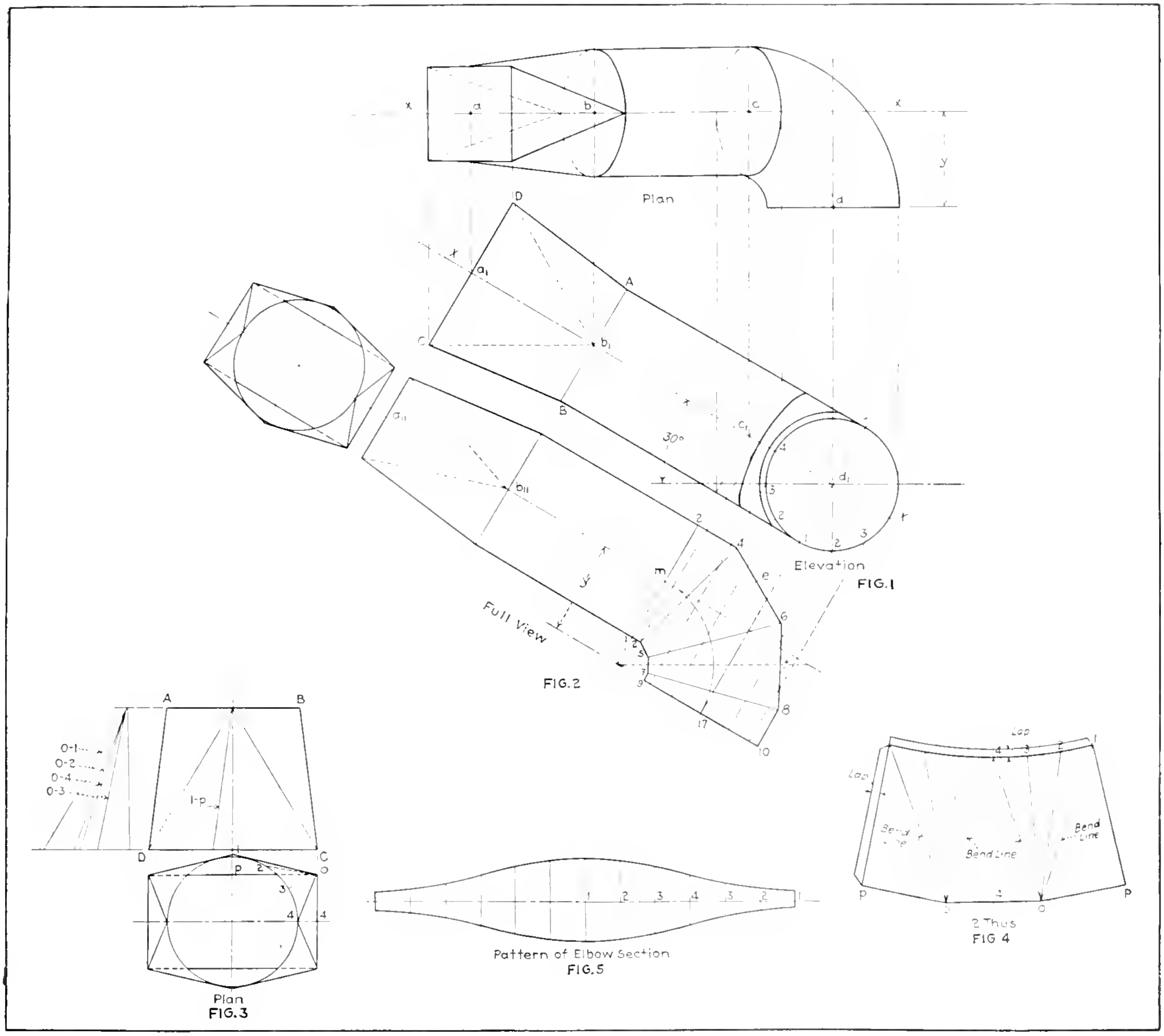
Q.—Please advise how to layout an elbow as per accompanying sketch. Also please advise where I can obtain a volume or two on advanced laying out. I have been laying out for several years and understand projection and triangulation but am far from knowing it all. I have a copy of your book "Laying Out for Boiler Makers," a course in the I. C. S. and all, or nearly all the copies of THE BOILER MAKER for the last several years. I have heard of a party somewhere near Huntington, Pa., publishing a book for layerouts, also something about the Chicago Technical Institute, but believe you can direct me to what I want.—G. A. H.

A.—From your sketch as reproduced in Fig. 1, which shows a plan and an elevation of the connecting pipes, as they are inclined to the horizontal as shown in the elevation at an angle of 30 degrees, the views of the elbow are shown foreshortened in both the plan and elevation. In such constructions the requirement is to show a full view of the connection as given in Fig. 2. Therefore, knowing the measurement *y* shown in the plan, Fig. 1, simply reproduce a new plan view as constructed at right angles to the elevation. Imagine, for illustration, that a plane is passed directly through the line *x-x* of the elevation, Fig. 1, and that it is turned about this line to bring it into a plane parallel with the horizontal, thus showing a full view of the elbow connection.

Lay off the center line a_{11}-m_1, Fig. 2, and from point *m* which is projected from the elevation, Fig. 1, lay off the distance *m-o* equal to *y* of the plan. With *o* as a center draw the arcs *2-10*, *m-n* and *1-9*. Divide either arc into one less than the required number of sections in the elbow, as *2-e*, *e-f*, *f-10* on the outer arc. Bisect *2-e*, locating point *4* and with the dividers set to *e-f* space off from point *4* the lengths *4-6* and *6-8*. Connect the points *4-6-8* with the center *o*, thus locating the miter sections of the elbow. The remaining construction of the elbow sections will be understood from the drawing.

In Fig. 3 is the layout of the transition piece. The dimensions are taken from the elevation, Fig. 1, and full view, Fig. 2. In this development triangulation is employed.

In Fig. 4 a one-half pattern is developed of the transition piece, which involves the transfer of the true lengths of the triangles, Fig. 3, and the use of the arcs of the upper and



General Details of Oblique Pipe Development straight lengths of the lower base. As the construction lines are numbered to correspond with those of Fig. 3 the respective steps in the development are evident. Fig. 5 is the development of the pattern of the elbow sections.

There are several text-books on projection triangulation, and I believe that with your I. C. S. course and the "Laying Out for Boiler Makers" you have sufficient information to handle problems of this kind. A thorough understanding of the principles of projection and triangulation is essential before practical layouts can be handled. The most difficult development is simply the application of these subjects, which involves several steps in the drawing work, to show a complete full view, or development of triangles to obtain the true lengths of foreshortened construction lines.

There is published by the Sheet Metal Worker, 17 East 40th street, New York City, a volume on sheet metal layouts, known as Kittredge's "Sheet Metal Pattern Book." This volume pertains to layouts produced for the lighter sheet metals and it is an excellent treatise.

Stack Proportions

Q.—We have two 125-horsepower return tubular boilers which have individual stacks 34 inches diameter, 60 feet high; boilers have 25 square feet of grate surface each. We have to build new stacks and I have suggested that one stack of larger area be built. From my present supply of information I find that a stack 48 inches in diameter would be equal in volume to the two 34-inch stacks. As the whole job of designing and laying out is left to me I want to be sure of not bungling the job, but there is a formula that the exact size and height of stack can be figured from grate area and heating area and also coal consumption by using these factors.—O. G. M.

A.—The proper size of stack or chimney depends on the amount and nature of fuel to be burned, grate area, temperature of the gases, design and arrangement of the flues and the altitude of the boilers above sea level. The draft depends on the height of stack and the gas temperature, which increases with the temperature of the gas.

The stack should be higher at high altitudes than at sea level because of the lower atmospheric pressure. With natural draft, it will be affected by the gas temperatures. It is also more intense on clear dry days than in hot sultry weather; due to the changes in atmospheric pressure and the fact that in the latter case the higher moisture content in the air absorbs heat and retards combustion in the fuel bed.

Some authorities proportion the diameter of the stack according to the grate area; thus for watertube boilers the area of a stack at its smallest end should equal at least one-fifth the total grate surface area where the stack is less than 150 feet high. In cases where the stack height is greater than 150 feet, the smallest cross sectional area of the stack should be not less than one-sixth the total area of the grate surface. For boilers of the horizontal return tubular type the stack should be proportioned so that the cross sectional area at the smallest end is 25 percent in excess of the combined cross sectional area of the tubes.

The retarding effect of the draft due to the friction of the gases is equivalent to a lining 2 inches in thickness. The effective area of a stack for both round and square equals $A - 0.6\sqrt{A}$, in which A = Area of stack in square feet.

The height of a chimney should be sufficient to develop a draft greater than that required for its rated horsepower. Generally the height of the stack is assumed taking into consideration the surrounding buildings, draft required for the burning of the fuel and horsepower of the boilers. High stacks are expensive and objectionable from the standpoint of upkeep. Stacks are now rarely built over 150 feet high, as it is cheaper to build two or more smaller stacks in place of one larger one.

The minimum height varies with the fuel, (wood fuel requires the least height), then in order comes bituminous and anthracite coal. The small sizes of the latter require very high stacks to burn the fuel under natural draft conditions. To burn the buckwheat sizes the height of stack required under natural draft would be prohibitive. With mechanical or forced draft high stacks would also be needed, thus to burn 25 pounds of buckwheat coal per square foot of grate area would require a stack at least 175 feet high. The following table gives the draft pressure in inches of water required to burn some coal fuels on hand-fired grates.

Fuel Burned per Square Foot Grate Area per Hour	Eastern Bituminous Coal Slack	Western Bituminous Slack	Semi-Bituminous Run of Mine	Anthracite Pea Coal
	Draft Pressure, Inches			
10	.06	.07	.07	.15
15	.10	.13	.12	.27
20	.15	.19	.19	.43
25	.21	.26	.28	.63
30	.27	.35	.38	.86
40	.42	.54	.62	
50	.61	.78	.93	

When the draft required and the temperature of the outside air and stack gases are known, the required height of the stack may be determined by the formula:

$$H = \frac{P}{\frac{7.6}{T_1} - \frac{7.9}{T_2}}$$

in which: H = Height of stack in feet.
P = Draft pressure, inches of water.
T_1 = Absolute temperature of outside air.
T_2 = Absolute temperature of chimney gases.

To determine the absolute temperature referred to add 460 degress in each case.

Example: The outside temperature of the atmosphere is 62 degrees and the chimney gases 550 degrees F. What height of chimney is required to produce a draft of 1 inch.

Solution: By the formula

$$H = \frac{P}{\frac{7.6}{T_1} - \frac{7.9}{T_2}} = \frac{1}{\frac{7.6}{522} - \frac{7.9}{1010}} = 149 \text{ feet.}$$

$T_1 = 62 + 460 = 522$ degrees.
$T_2 = 550 + 460 = 1010$ degrees.

Kent gives the following formula for stack proportions:

If the horsepower of the boiler is given and the stack height is assumed, then the effective area of the stack may be found as follows:

$$E = 0.3\ H.P. \div \sqrt{H}$$

in which E = effective area in square feet.
$H.P.$ = horsepower of the boiler.
H = stack height in feet.

If the horsepower is given and the cross sectional area is assumed, the height of the stack may be found from:

$$H = \left(\frac{0.3\ H.P.}{E}\right)^2$$

Building Plans and Specifications

Q.—Would you kindly advise us if you can refer us to anyone who has blueprints and drawings suitable for a boiler shop large enough to manufacture boilers up to 72 inches diameter by 18 feet? We have seen a number of good designs in THE BOILER MAKER, but they are too large for the purpose we have in mind.—W. T. F.

A.—For the purpose you have in mind I would suggest that you investigate the industrial buildings erected by concerns specializing in such constructions. For further particulars write to Truscon Steel Company, Youngstown, Ohio; Frank D. Chase, Inc., 645 N. Michigan avenue, Chicago, Ill., and Beling-Bush Company, Drexel Building, Philadelphia, Pa.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Supervision of Boilers in Country Districts Necessary

On June 3 at 10 A. M., a 30-horsepower boiler of the wet bottom locomotive type and located on the Hosmer Farm at Olean, N. Y., exploded. There was no loss of life and very little property damage considering the violence of the explosion.

We made an investigation of the wreckage on the following day and have concluded that it was a miracle that it had not blown up before. The original thickness of the barrel plates and wrapper sheets was 5/16 inch and of the firebox sheets 1/4 inch. The firebox and wrapper sheets were pitted and grooved in some places so that they were only 1/16 of an inch thick.

The staybolts in the side sheets were originally 3/4 inch in diameter and were spaced 4 7/8 inches by 5 inches. The steam gage registered 80 pounds pressure not more than one minute before the explosion but, as the gage was not tested before, as far as records can be found, it cannot have any reliance placed upon its reading. The boiler was also equipped with a lever safety valve but this could not be found.

The barrel of the boiler fractured at the throat sheet near the seams, it being grooved at the throat sheet and pitted so that it was not over 1/8 of an inch thick, the plate also tore at the rivets connecting the barrel and wrapper sheets. The barrel was found about 100 feet ahead of its original setting.

The dome was located over the firebox and the dome, wrapper sheet and outside firebox sheets were found upon a hill elevated about 100 feet and at a distance of 825 feet ahead of its original setting. Investigation showed that five staybolts were broken entirely off on the right side and all the remainder were cracked so that some only held by 1/8 of an inch.

The firebox proper was found about 275 feet to the left of the original setting and was pitted and grooved excessively. The staybolt heads pulled from most every hole in the firebox. The firebox door was found about 400 feet to the rear and had made a path through the trees showing where it had traveled.

Defects Found in Boiler

In making the examination, the following defects were found: Sheets and tubes wasted and corroded throughout the boiler to a thickness of 1/16 inch in places; three broken braces connecting barrel and flue sheet together; one broken back head brace; five broken bolts and all the rest cracked on the right side; radiating cracks around the staybolts which had been acetylene welded one week previous.

Fig. 1.—View of Firebox After Explosion. Fig. 2.—Sheet from Right Side of Boiler. Fig. 3.—Barrel Sheet and Tubes. Fig. 4.—Dome and Wrapper Sheets

This boiler was about 20 years old, never inspected, poorly constructed and attended to. About one year previous to the explosion a boiler maker applied a patch extending the full length of the firebox and taking in two horizontal rows of staybolts. He informed the owner that the boiler was unfit for service, but the owner did not heed the warning. He also notified the inspector in this district but neither did he make an inspection and condemn the boiler.

At the time of making the repairs, it was found that horse manure was put into the boiler in large quantities to stop previous leakage. The cause of the explosion is very evident and easily determined. The law states that all portable and stationary boilers carrying 15 pounds pressure or over are subject to inspection; also, that the owner or user shall notify the state of the location of the same annually.

There is no record of inspection on the boiler and there are several more right close by which are evidently in the same condition. Summing up the whole matter, we find there are only about 10 state inspectors to cover the entire state and each one covers from four to seven counties, their work covering portable and stationary boilers. They cannot possibly do justice to their work by having so much territory to cover. Country boilers which are in very bad condition compared with those located in the city need inspection very badly. It should be made a law or rule that repairmen must report all boilers they work on, so that all of them could eventually be located.

Olean, N. Y. C. W. CARTER, JR.

Accuracy in Boiler Making

No doubt many of the readers of THE BOILER MAKER have heard the common expression that a boiler maker never works closer than one-fourth of an inch. Indeed there is a large percentage of boiler makers and layerouts who work closer than one thirty-second of an inch. There are really few layerouts of today who do not work closer than one-fourth of an inch, while of course there are a great many who have the habit of calling one-eighth inch close enough.

I have observed the work of a number of layerouts in various shops and I find that many really work to one sixty-fourth of an inch in laying out holes and find it much easier and quicker. Accuracy is a good habit on anything and an ounce of prevention is worth a pound of cure; the cure being for inaccurate work such things as drift pins, reamers, acetylene burners and sometimes the welders. While I do not mean that a man should waste any extra time to make a hole come to one thirty-second of an inch, yet the expressions as, "Oh, that is all right, you can pin those few holes"; or, "What do you suppose reaming machines are for?"; or, "If we did not have any bad holes we would not need a reamer around the shop," are only too common.

On the one hand, there are cases where each man depends on the next man to make it right. The layerout will let it slip a little, the punch machine man will do the same, the shear man will let it slip from the line, and when the fitter puts it together, he somehow or other gets it there regardless of fair holes, as he also is used to work that requires reaming and pinning before the rivets can be put into the holes. On the other hand, there are cases where the boiler maker will put a job together that has been laid out to perfection and instead of fairing the holes before pulling the bolts tight, he is satisfied to get a bolt here and there, even if he must pin to get the bolt in the hole. He does this instead of looking around and seeing what is holding the job off, fairing it up, and putting pins in the holes to hold it fair while the bolts are being pulled tight. This fairing up of the job makes it look better, makes better rivets and is much quicker than the careless way of fitting up a job and letting the other fellow worry about fair holes.

I have seen many large difficult jobs on which the holes looked as if they had been drilled through after the work was assembled, but such was not the case. This type of work was only the result of careful and accurate workmanship throughout the shop; *i. e.,* beginning with the layerout and then through the works. This class of work seems to be the result in the most successful shops where riveters drive rivets of various sizes of three-eighths up to one and one-fourth inches in diameter day in and day out, never having to use a pin to get a rivet in the hole except on break-downs where the plates have been scarfed. And so the better class of work, the neater looking work and the cheaper work is the result of accuracy on the part of each one of the many workmen coming in contact with the job.

As almost everyone knows, there are many advantages gained from turning out good work and having men who know how to do the best work. For when a boiler or tank shop turns out a fabrication job that the purchaser intends erecting himself or subletting the erection, many times a haphazard misfit job will give the shop that turned it out a "black eye," and regardless of how much cheaper he may be on other work he has a hard time of landing any good jobs from them. Thus extra good work is somewhat like a silent salesman, landing many a good contract in the future.

I will say however that the shops in the United States today exceed by far any other country in the production of general steel plate work due mostly to the fact that employees and employers in this country as a whole are never satisfied with present arrangements and are always on the lookout for improvements, trying to do more today than they did yesterday, keeping in mind the old saying, "always try to do this job a little better than the last job." This again brings us back to *accuracy.* Here we have still a greater incentive for doing good work: it gives a fellow pride and interest in his work, making the work a pleasure, thus benefiting directly himself.

Kansas City, Kansas. LAWRENCE MCCARTHY.

OBITUARY

James T. Goodwin, well known to all the boiler making fraternity, died January 5, at the Memorial Hospital, New York, at the age of sixty-two years after a six weeks' illness.

James T. Goodwin

He was born in Water Valley, Miss., in 1860, and learned the boiler maker's trade in the shops of the Illinois Central Railroad. At the age of twenty-one years he was made a foreman. In 1899 he resigned his position as foreman boiler maker at Water Valley, Miss., to accept a position as superintendent of the boiler department in the locomotive works at Patterson, N. J. He resigned from this connection in 1900 to become superintendent of the boiler department of the American Locomotive Works, Richmond, Va. From here he went with the National Tube Company in 1909 to promote the use of steel boiler tubes and pipe. Mr. Goodwin was one of the leading boiler makers of the country and at various times has been president and secretary of the Master Boiler Makers' Association; president of the society of Past-Presidents of the Association and chairman of the committee on law. He was also a member of the New York Railroad Club.

ASSOCIATIONS

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TRADE PUBLICATIONS

Steel Sections.—The use of steel sections for overhead shafting and anchorage service is described in a pamphlet issued by the Midwest Steel and Supply Company, New York. The sections comprise box rails, socket inserts and steel stringers. Sectional views of these products with illustrations of various applications are given.

Corrosion.—The subject of pipe corrosion is discussed in Bulletin No. 3-C issued by the National Tube Company, Pittsburgh, Pa. It is agreed by authorities that oxygen holds the dominating position together with the electrochemical theory in causing internal corrosion. An explanation of this action is given in the bulletin together with the details of the mechanism of corrosion in abstracts from papers which have been delivered before various professional societies. Practical means of preventing corrosion are outlined and the results which may be expected from various methods of water treatment and the like.

Spiral Riveted Pressure Pipe.—The American Spiral Pipe Works, Chicago, Ill., in a well illustrated catalogue describes the manufacturing process and tests through which various forms of Taylor spiral riveted pressure pipe pass in fabrication. Protective coatings of asphalt and galvanizing material are used for the protection of the pipe. Numerous applications of spiral pipe to industrial uses are included. The catalogue is so arranged that the price lists are easily accessible. Several pages have also been devoted exclusively to a collection of hydraulic tables and charts.

International Boiler Works.—The International Boiler Works located at East Stroudsburg, Pa., has issued a catalogue outlining the facilities of the plant and products of the company. The plant is one of the most modern in arrangement and equipment in the country for the production of horizontal boilers, vertical boilers, marine boilers, tank and plate fabrication. Complete details of the machinery, process of fabrication with numerous illustrations of the various types of boilers built make up the body of the catalogue.

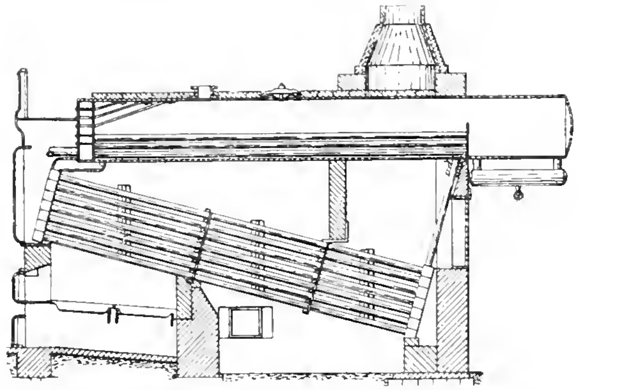
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,432,941. WATER PURIFIER FOR STEAM BOILERS. GEORGE J. WOODHOUSE, OF OELWEIN, IOWA.

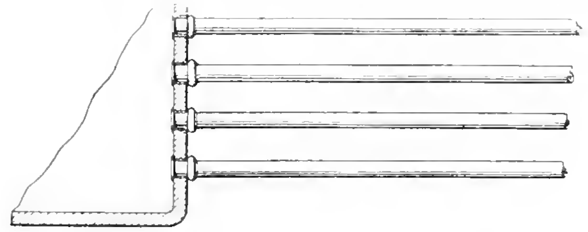
Claim 1.—In combination, a boiler, a separating-drum positioned thereabove having a closed chamber at one end and having a transverse-partition spaced from the other end, the upper part of said partition being removed,



said closed chamber being in communication with a source of water supply, water-tubes positioned in the lower part of said separating-drum with their forward ends in communication with said closed chamber and their rear ends traversing said partition, and water-legs effecting communication between the forward and rear ends of said boiler and the forward and rear ends respectively of the lower part of said separating-drum between said closed chamber and said partition. Three claims.

1,438,596. BOILER. HARVEY HARDING, OF EAST ORANGE, NEW JERSEY.

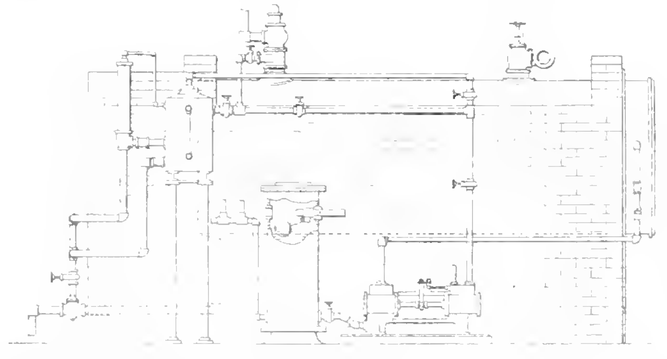
Claim 1.—The combination in a boiler construction, of an apertured tube sheet, flue tubes extending transversely through the apertures of the sheet and secured at one end to the sheet, copper collars lining the apertures of



the tube sheet, and coatings of copper on and exterior of the tubes and extending a distance from the tube sheet and interposed between the said tubes and the copper collars, whereby without interfering with the essential expansion and contraction of the tube connections passage of electric current from the tubes through the water to the collars is prevented. Two claims.

1,435,546. BOILER-FEED REGULATION. JAMES H. MURRAY, OF WATERVILLE, MAINE.

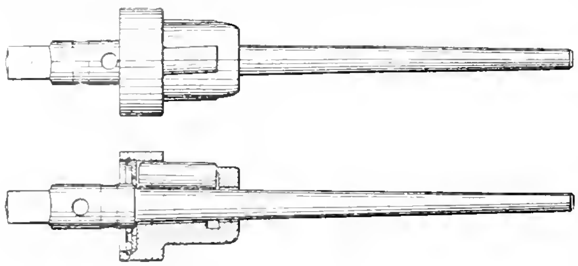
Claim 1.—The combination with a boiler, a feed pump, a regulating device, pipe connections between the boiler and regulating device and between the latter and the feed pump, and a valve controlled by the water level in the



regulating device to control the passage of steam to the pump, of feed water connections between the boiler and the regulating device and comprising two pipes spaced apart vertically and both communicating with the regulating device below the normal water level of the boiler. Thirteen claims.

1,439,569. BOILER TOOL. GRAVES R. MAUPIN, OF MOBERLY, MISSOURI, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE J. FAESSLER MANUFACTURING COMPANY, OF MOBERLY, MISSOURI, A CO-PARTNERSHIP COMPOSED OF JOHN W. FAESSLER, CHRISTINIA FAESSLER, LOUIS E. FAESSLER, AND GRAVES R. MAUPIN.

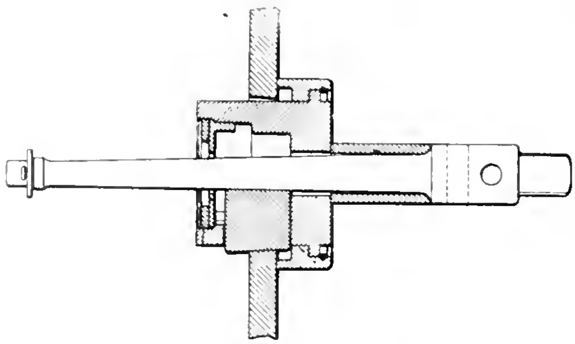
Claim 1.—A boiler tool comprising a tapered mandrel, a cage formed of a solid piece of material, said cage provided on one of its ends with a counterbored enlargement, a cylinderical opening extending centrally through said



cage, said opening adapted to receive the mandrel, a plurality of openings disposed radially to the central opening and diagonally thereto, said openings being oval in cross section and opening into the central opening and on the outside cylinderical surface of the cage, a plurality of rollers located in said openings, a thrust collar secured to said cage, and a split spring ring for securing said collar to said cage. Two claims.

1,439,622. BOILER TOOL. JOHN W. FAESSLER, OF MOBERLY, MISSOURI, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE J. FAESSLER MANUFACTURING COMPANY, OF MOBERLY, MISSOURI, A CO-PARTNERSHIP COMPOSED OF JOHN W. FAESSLER, CHRISTINIA FAESSLER, LOUIS E. FAESSLER, AND GRAVES R. MAUPIN.

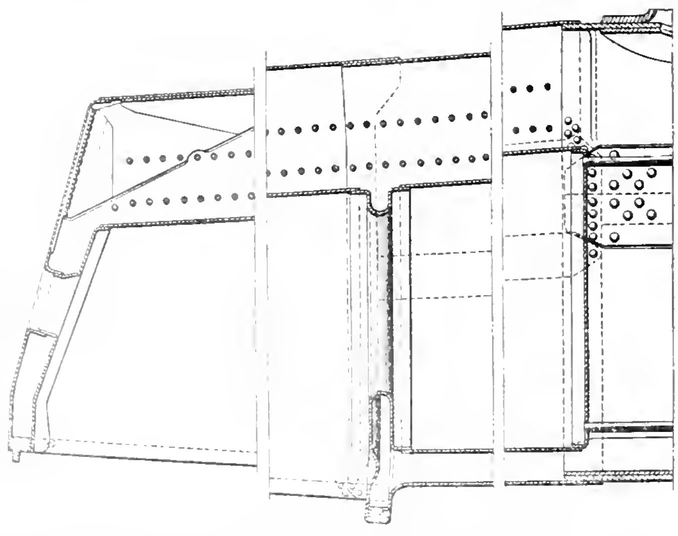
Claim 1.—A boiler tool comprising a cage, a tapered mandrel extending through said cage, rollers mounted in said cage at an angle to its longitudinal axis and capable of being extended through its outer periphery, a



friction collar rotatably mounted on said cage, means carried by the friction collar for holding it on said cage, means carried by the mandrel and adapted to contact with the cage for limiting the movement of the mandrel through said cage, and a roller retainer located within the cage for holding the rollers therein when the mandrel is withdrawn. Three claims.

1,433,378. STEAM BOILERS. WILLIAM F. KIESEL, JR., OF ALTOONA, PENNSYLVANIA.

Claim 1.—An expansion member for connecting the shell sections of a boiler containing the fire box and combustion chamber consisting of two parts welded together, one formed of a strip bent transversely to make a



hollow rib and side flanges, and the other bent to form a continuation of said hollow rib and flanges and extending downward and transversely at one side to constitute the front end of the fire box, substantially as set forth. Three claims.

The Boiler Maker

FEBRUARY, 1923

Equipment for Locomotive Boiler Repair Shops

Arrangement, Types and Capacities of Machines for Use in Carrying Out Major Boiler Work

Most of the railroad boiler repair shops are equipped to accommodate the locomotives coming within their territory for maintenance but not all of them utilize the most efficient types of machines and the best floor layout of machinery to accomplish the desired results. The handicap thus imposed generally must be overcome by employing an increased staff or by pushing the existing staff harder than would ordinarily be necessary. Some suggestions to overcome certain of the inefficiencies may be gained from a study of the following general details of a typical average shop layout.

Boiler Maintenance Improved During Past Year

During the past year, and especially in the last months of 1922, the railroads throughout the country have made good progress in putting their motive power in condition to meet the increased traffic demands. As a measure of this improvement in maintenance, the report of the chief inspector of the Bureau of Locomotive Inspection indicates that locomotive failures, particularly boiler accidents, have decreased materially. The factors entering the improved condition of power include adequate inspection, both by government and railroad staffs, the skilled men in the shops and modern, efficient equipment. The full importance of the last item is now being realized in the smaller shops as it has been for a long time by the larger systems.

Boiler shops are in general given rather less consideration in the matter of layout and equipment than is true of machine shops, for example, and yet on the work of the boiler shop depends the efficiency of the entire machine.

Equipment Requirements for An Average Shop

Whether the shop be large or small, certain tools must be included in the equipment to properly handle the boilers that come in for repair. What these tools are and how they may be used to best advantage have been the subject of a great

Note—The photographs used to illustrate this article were supplied by the Niles-Bement-Pond Company, New York.

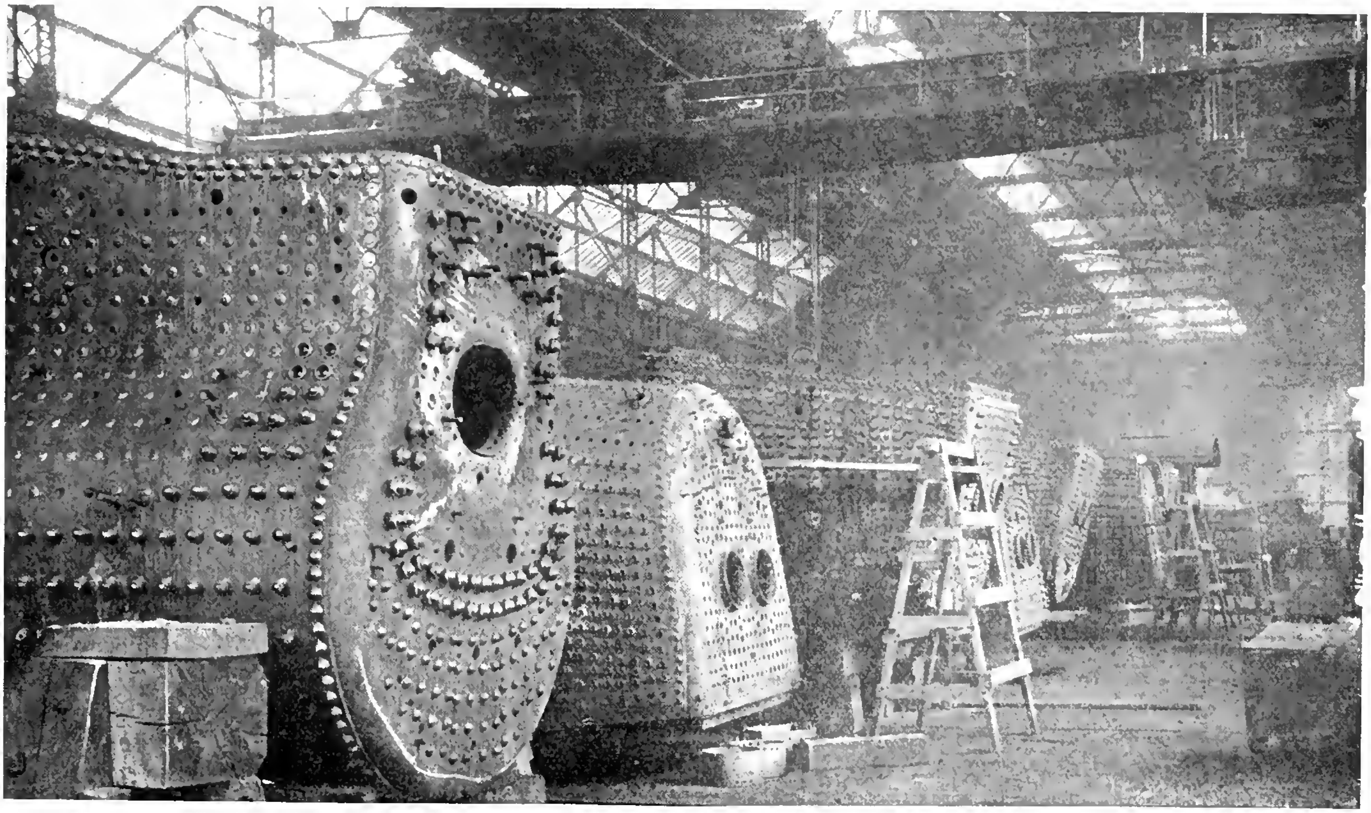


Fig. 1.—Group of Fireboxes Under Process of Repair in a Modern Boiler Shop

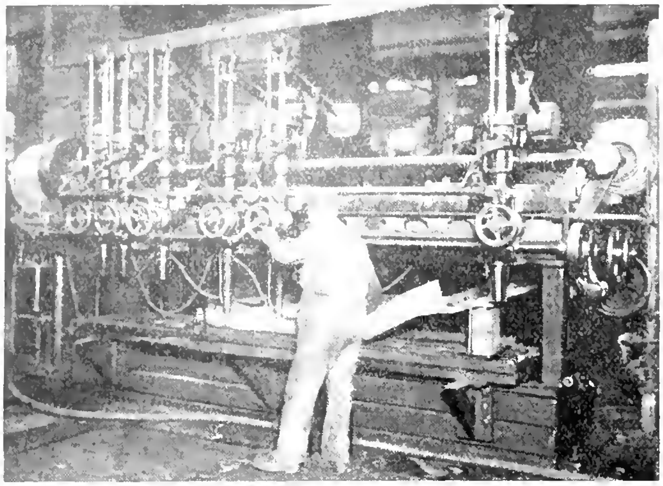


Fig. 2.—Multiple Spindle Drilling Machine Boosts Production

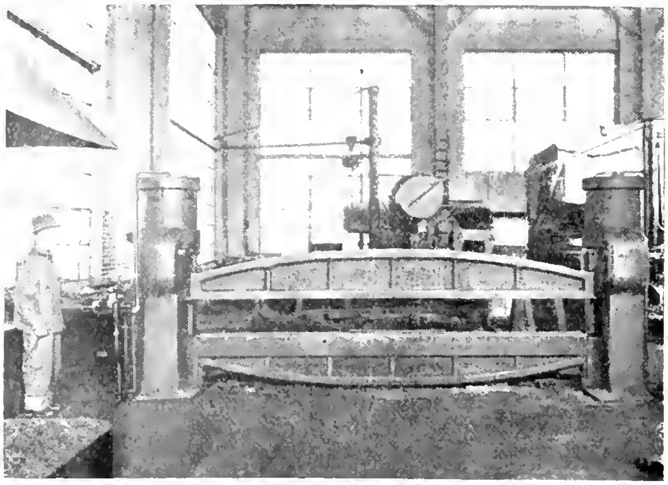


Fig. 4.—A Plate Flanging Machine is Indispensable

deal of study by both railroad engineers and those of the equipment manufacturers with the result that it is possible to equip a shop with standard tools that will take care of a given number of locomotives in the most efficient manner possible without installing any unessential machinery.

The equipment of the shop must provide for practically all plate work necessary on the locomotive and should therefore include the superheater, tank, cab and sheet metal departments as well as the boiler department. If the shop is of moderate size it should be equipped to take care of the complete construction of the firebox and repairs necessary as well as the construction of a complete boiler in case of emergency.

Factors Entering Shop Design

Of prime importance in planning a new shop, or increasing the efficiency of an existing repair plant, is the lighting, both natural and artificial. The results to be expected from the equipment in the shop depend in a great measure on this matter of proper lighting. Another point to consider is the provision of adequate handling facilities for parts to be moved from the erecting shop or other departments of the plant into the boiler shop. Any weight up to a complete boiler must be provided for. Traveling cranes of various capacities, truck and track arrangements are necessary for this service and, in the boiler shop itself, many jib cranes should be installed adjacent to machines, for they aid production without interfering in any way with the fabrication processes. These of course are installed in addition to the regular crane equipment in the boiler bay.

The location of machinery is of extreme importance but before considering this phase of the subject an idea of the type, size and capacity of the essential machinery will be given.

In the class of heavy equipment, a radial drill for flue sheets and mudrings of at least 6-foot capacity should be installed; a set of bending rolls capable of handling plates at least up to 14 feet by 7/8 inch; a hydraulic riveter for fireboxes and shells and a mudring riveter. In this connection, where it is at all possible, the rivets should be pressure driven. For flanging, a 10-foot flanging clamp and a universal flanging press are necessary. For plate work, an 18-

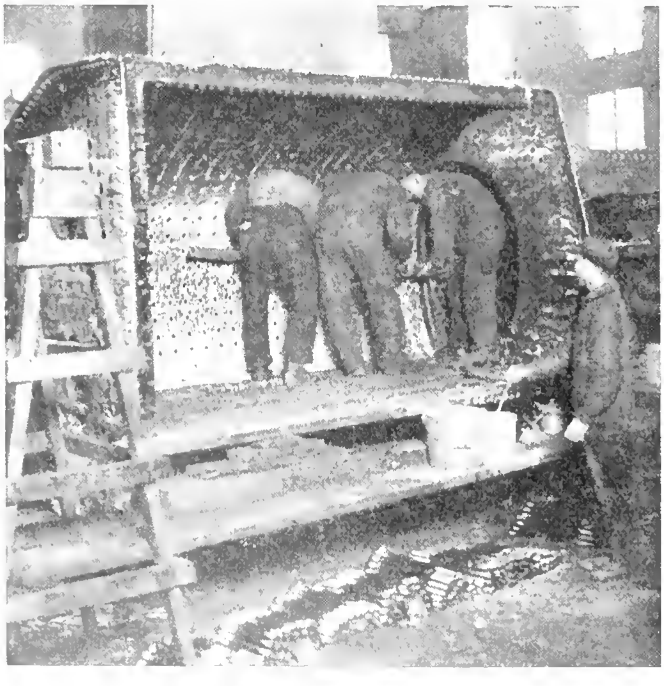


Fig. 3.—Replacing Tubes in a Boiler After Cleaning and Safe Ending

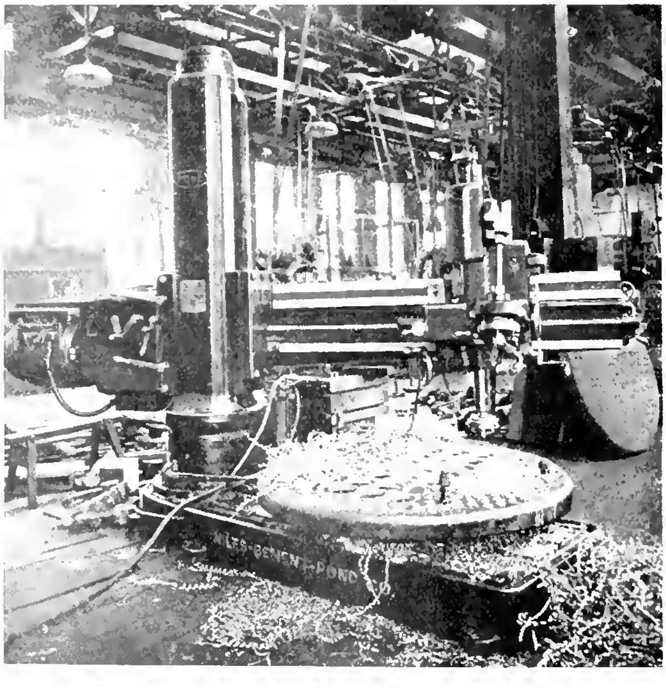


Fig. 5.—Flue Sheet Drilling is Speeded Up with a Right Line Radial

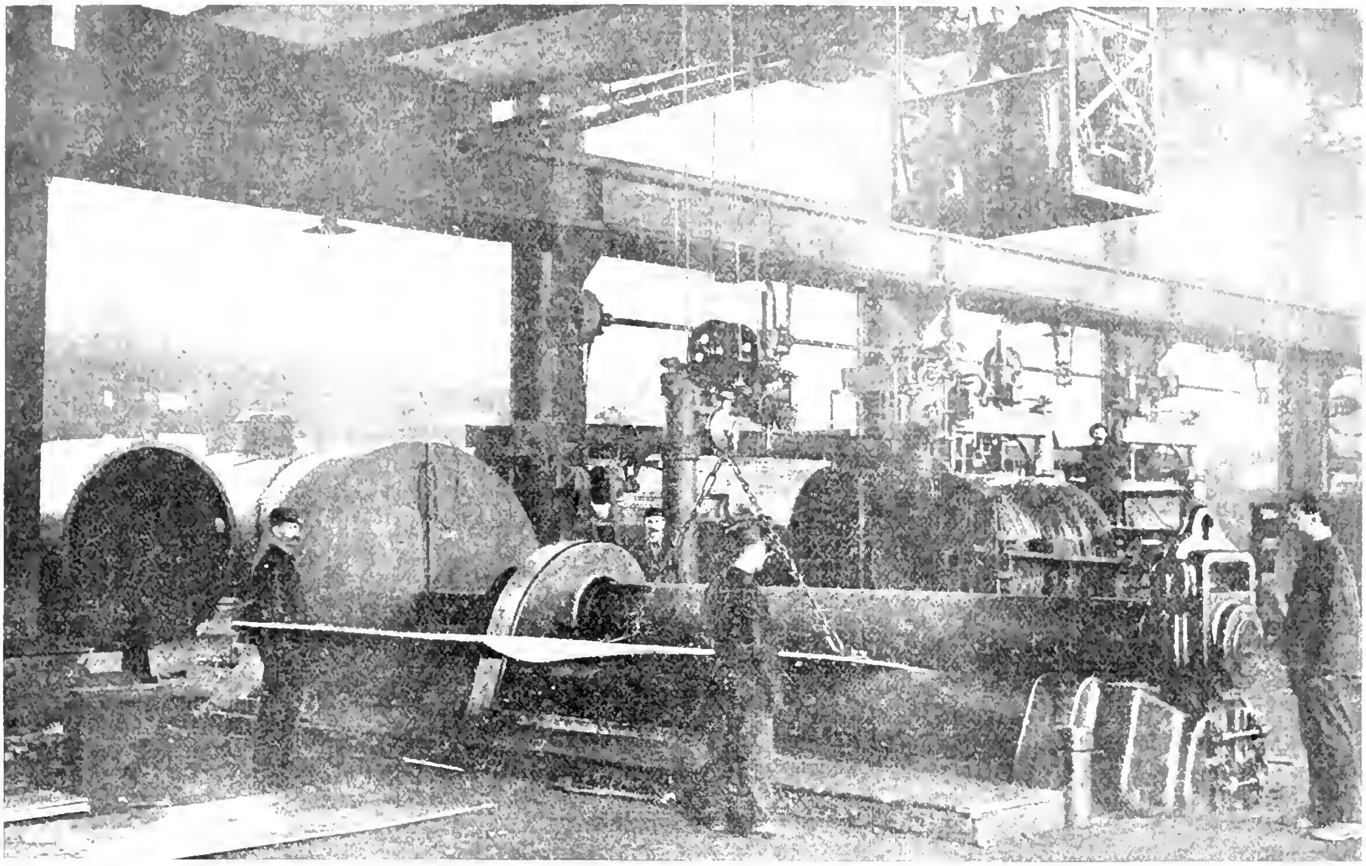


Fig. 6.—Heavy Bending Rolls Provide for the Boiler Shell and Heavy Tank Work

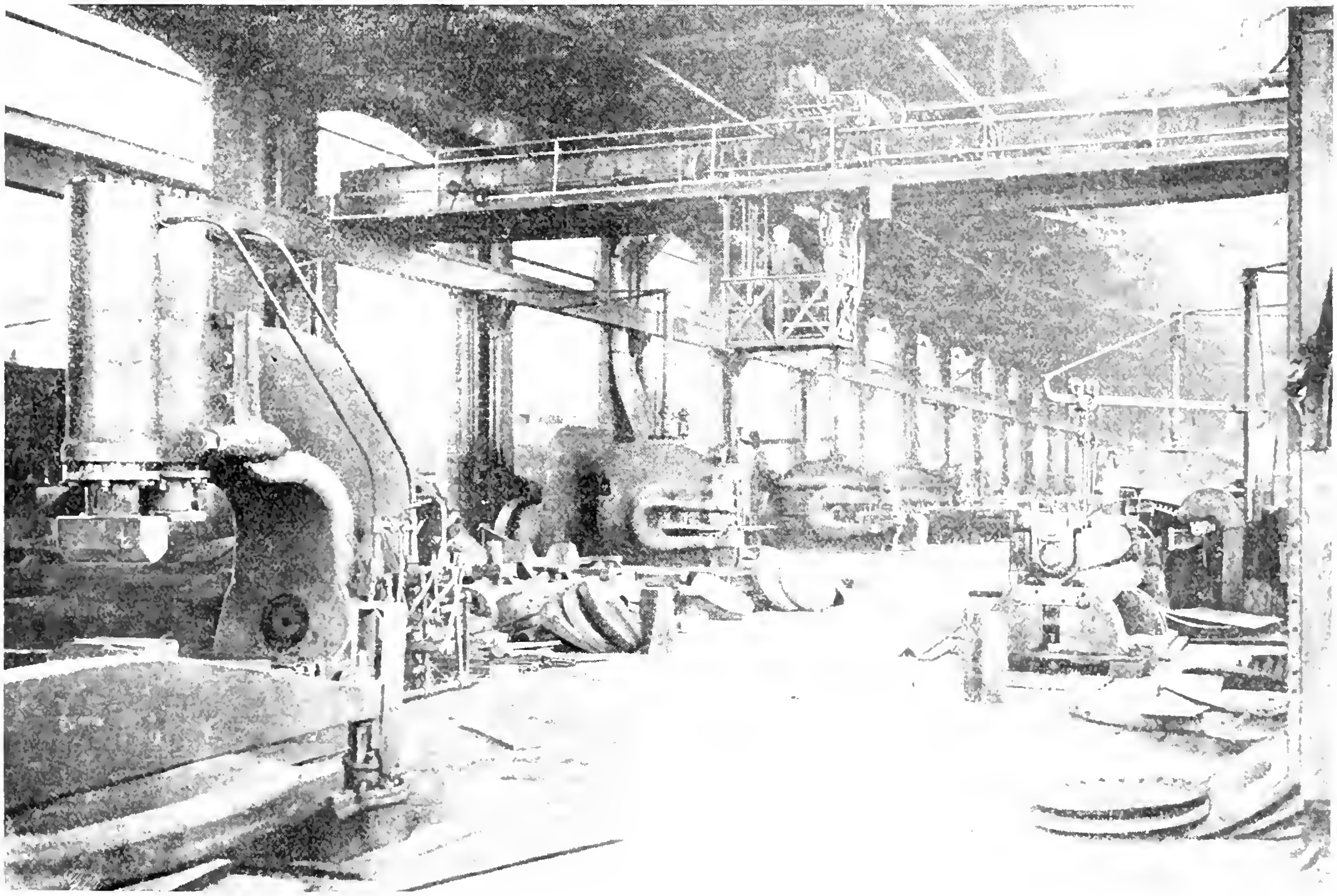


Fig. 7.—Battery of Shears and Punches in a Well Equipped Boiler Department

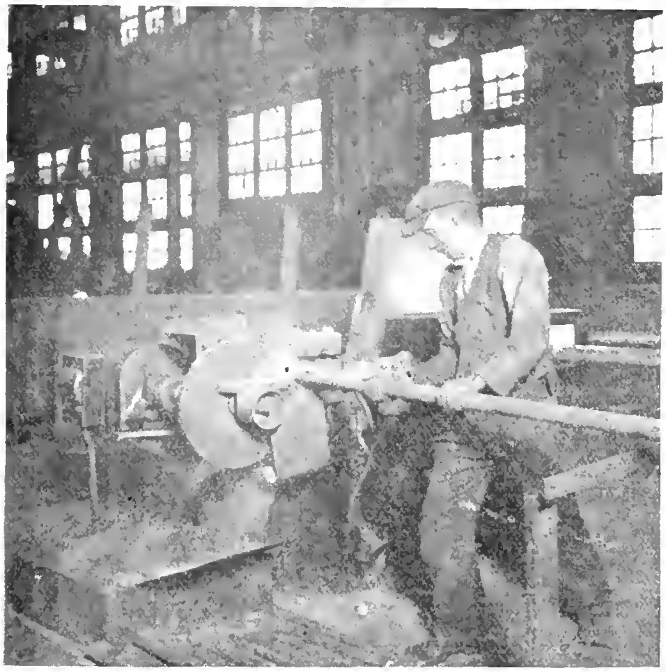


Fig. 8.—The Hot Saw is a Necessity in the Flue Department

inch horizontal punch, 66-inch vertical punch and a 66-inch vertical shear should be provided.

Staybolt work requires a double staybolt cutter for 1½-inch bolts, a 4-spindle drill, a two-head 1½-inch bolt shear, a 2-inch bolt pointer, a bar iron shear, a 17-inch engine lathe for crown stays and the like. There should also be a hand milling machine for squaring staybolts. About the only other essential in machine equipment is a two-wheel dry grinder for miscellaneous grinding and a single spindle sensitive drill for general service. A complete small tool outfit, pneumatic and electric, as well as oxy-acetylene and electric cutting and welding apparatus are a necessary part of the shop equipment.

Flanging and forge fires are of course required adjacent to the flange press and the staybolt department.

Machinery for Tank and Plate Work

In the section for tank and plate work a universal plate cutter, having a 48-inch throat and capacity for one-inch plate, to be used in tank and cab plates, ashpan and miscellaneous fabrication are essential. A 48-inch vertical punch, a 10-foot by ⅞-inch plate bending rolls and one for 6-foot by ½-inch plate are necessary. The latter is used for cabs and ashpans. In the pneumatic machine equipment of this section are a portable pneumatic riveter and a 10-foot pneumatic flanging clamp. A 7-foot diameter open fire should be built in to serve the flanger.

The flue department should have a high capacity flue cleaner or rattler, a 2-inch pipe cutting and threading machine, a safe end cutting off machine, a hot saw and expander, a flue welder, welding furnaces, grinding rack, testing rack and an accumulator and pump for testing. All of this equipment will assist materially in boosting shop production. The capacities might vary to meet special requirements but, in general, the size of machines given is ample for regular work.

Shop Layout of Machinery

The question of the proper placing of machines in relation to the general scheme of production and to each other will materially affect the smooth and efficient operation of the shop. Generally the boiler shop is located in one of the bays of the main shop and at no great distance from the erecting floor so that traveling cranes or trucks are able to handle parts back and forth without relaying them.

At one end of the boiler shop the plate storage and layout section is located from which plates are conveyed into production. The first question that occurs in planning the layout of machinery is which group of machines should be located adjacent to the layout floor. The flue work and the tank and plate work can well be segregated as sub-departments and will be discussed later. The flanging and drilling department for the heads and the boiler barrel section will also be considered as sections of the shop.

The work must go through the shop in a straight line and without being shuttled back and forth in any department. Small work should be handled by jib cranes from one machine to the next process without requiring the service of the main or auxiliary cranes. Auxiliary lifts on the main crane are essential; for speed and economy in handling, it should not be necessary to use the heavy cranes for shifting materials of light weight.

Layout of a Typical Shop

In the layout of a well designed, modernly equipped shop for example on one of the larger systems, the grouping of machines is approximately as follows:

Near the plate layout and storage department are placed a general service flanging press and a flanging clamp with the plate furnace between so that the jib cranes located adjacent to each machine are able to pick up plates to be flanged from the laying out section and serve them to the fires or presses

In the next group of machines are included a horizontal punch, a vertical punch and a vertical shear, each served by a jib crane, the arcs of which overlap the range of the others so that handling of plates from one process to the next is accomplished with a minimum of manual labor. In this same division of the shop is a radial drill served by a jib crane. Thus in this section are located all the machines that are necessary for carrying the flat plate work through to the point of assembly in the firebox or boiler.

Ranged along the wall side of the shop in order to take advantage of the natural daylight are the small machines used in connection with the preparation of staybolts and crown stays. These machines include the regular equipment found in most shops—an engine lathe and power shear, bolt

Fig. 9.—Welding Furnaces and Pneumatic Welders in Action

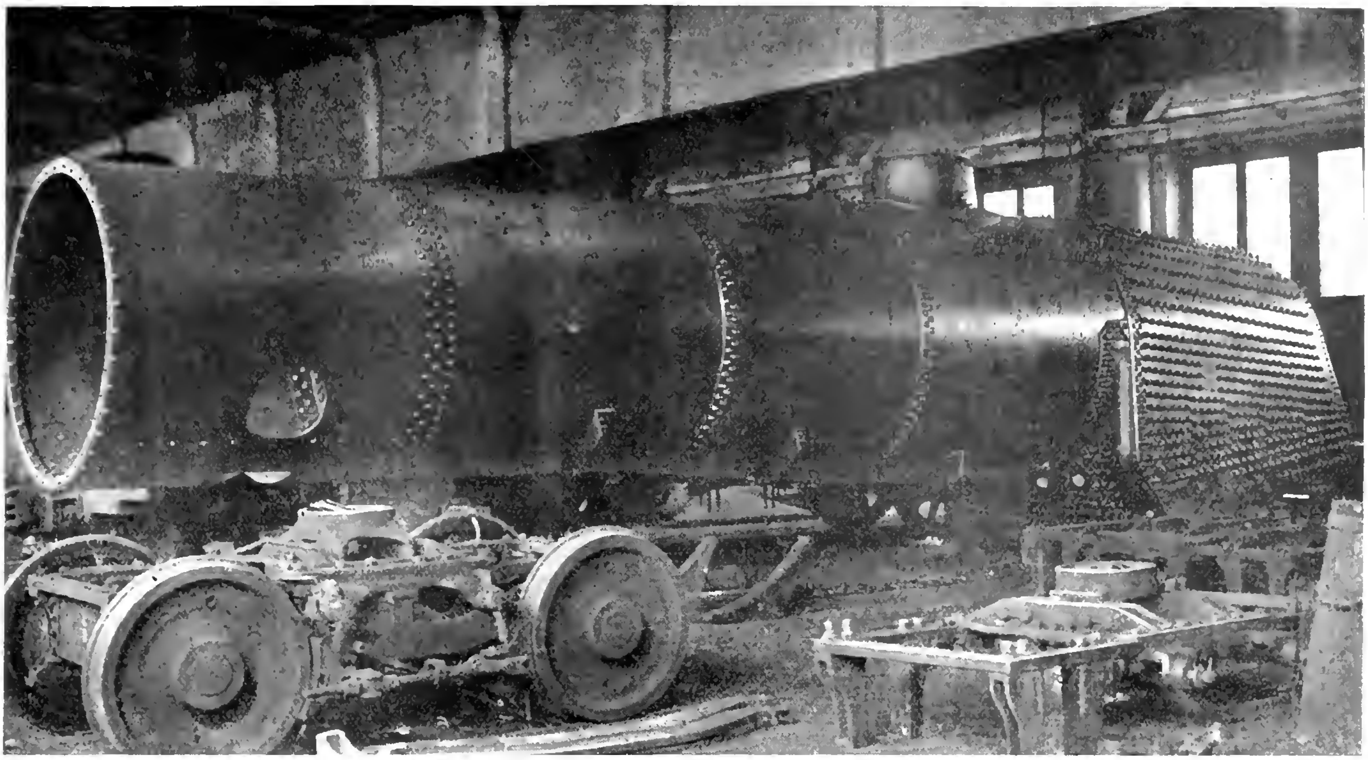


Fig. 10.—The Finished Boiler Ready for Assembly on the Trucks

pointer, a two-head bolt shear, a four-spindle drill and a staybolt cutter. In addition, there are a dry grinder, a hand drilling machine and a service drill adjacent to the staybolt machines.

In this shop the flue section is located next in the order of departments and, as this is actually a section accomplishing an independent process in the scheme of production, the most important consideration is that it shall be adjacent to the assembly. In this department the layout of machines depends largely on the type of equipment used; that is, whether the welding machines are pneumatic or electric in operation.

The flue department layout is a complete study in itself; as it has been thoroughly discussed in previous issues of The Boiler Maker, it will not be repeated at this time.

There remains, however, the boiler barrel work to be completed and the machines for this are arranged in a section of the bay next to the flue department. A feature of this section is that an individual overhead crane serves the department which includes the bending rolls and the hydraulic riveter.

With the three sections working simultaneously the material reaches the assembly floor at a rate designed to meet the repair requirements of the shop and, after assembly and hydrostatic test, the completed boiler can be carried to the erecting floor according to the shop schedule arranged.

Details of Tank Department

There remains only the tank and plate department which is closely allied to actual boiler work. The various plate cutters, punches and bending rolls, drills and riveters are assembled as a unit in the shop and served by numerous jib cranes which make the department quite independent of the main cranes, except for handling finished cab assemblies and the like.

In the matter of small tools, electric and pneumatic, a shop should be completely equipped and care taken in the maintenance of such tools. In the tool room, testing devices should be provided for air tools as well as master gages for maintaining a high degree of accuracy in taps and dies. Complete oxy-acetylene and electric welding and cutting tools are of great importance in the conduct of repair work.

Adequate storage facilities in sheltered and convenient locations should be provided for plates, flues, superheater units, staybolt iron, firebrick and other materials entering into construction or repair work.

Conference on Proposed Safety Code For Plate and Sheet Metal Working

A conference is called by the American Engineering Standards Committee to determine whether there shall be

(1) A national safety code for the forging industry,

(2) A national safety code for plate and sheet metal working.

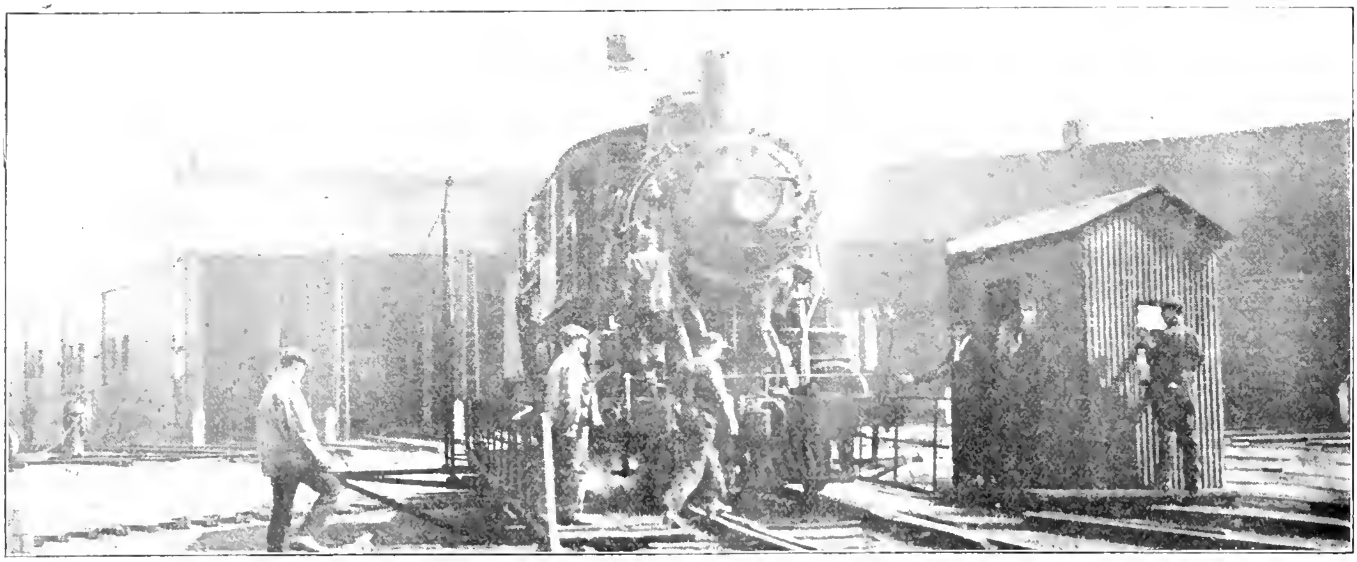
This conference will be held Saturday, February 17, at 9:30 a. m., in the board room of the American Society of Mechanical Engineers, 29 West 39th street, New York City.

The conference is called at the request of the Safety Code Correlating Committee, which has had the subject under consideration for some time as a result of proposals made to it that there should be such codes. After considerable preliminary study of the subject, the correlating committee recommended that the decision should be arrived at through a thoroughly representative conference of all interested bodies.

Committee Changes of the Master Boiler Makers' Association

Secretary H. D. Vought, of the Master Boiler Makers' Association, has announced that the vacancy in the chairmanship of the committee on law of the association caused by the death of James T. Goodwin will be filled by Thomas F. Powers, third vice-president of the association. The committee on memorials will be made up of George N. Riley, P. J. Conrath and J. W. Kelly.

The secretary wishes to remind the chairmen of the various committees that reports must be in his office by March 1 in order to prepare them for advance distribution to the members.



Erie Railroad Enginehouse at Jersey City, from Turntable Side

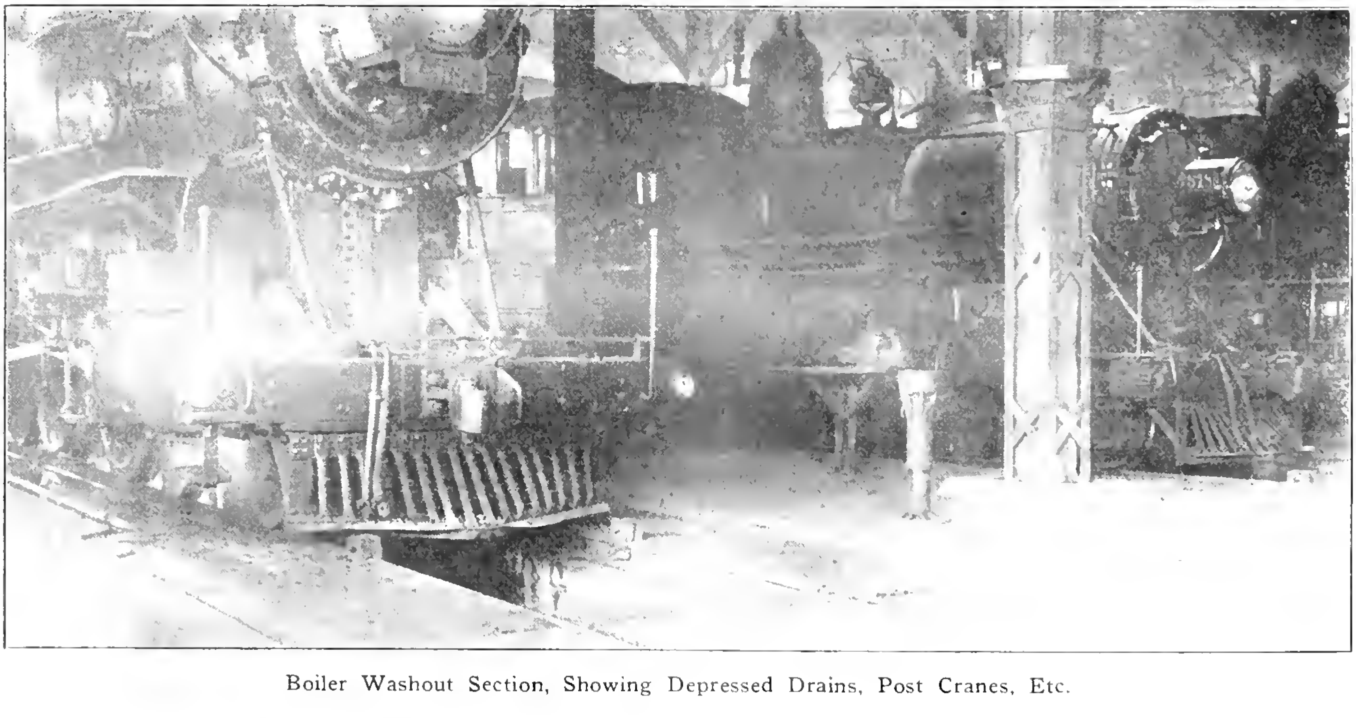
Repair Facilities at New Erie Enginehouse

Description of Locomotive Boiler and Machine Repair Shop of New Jersey City Engine Terminal

THE Erie Railroad has recently completed a new engine terminal at Jersey City, N. J., which includes a 21-stall enginehouse, machine shop and other facilities, the construction of which was carried on "under traffic." It replaces an old layout which was destroyed by fire and was built on the old site without interference with operation, the old turntable and radial tracks being kept in use for the turning and servicing of both passenger and yard locomotives. The new building is a combination of a radial type 105-foot enginehouse and a rectangular building. The old enginehouse was of timber construction with 21 stalls served by an 80-foot turntable.

The Jersey City enginehouse is primarily for the servicing of the commuter engines, although all of the New York division passenger locomotives and a few yard locomotives are also handled there. About 200 engines are turned daily at Jersey City which, in connection with the congested layout, presented a problem that was easily rendered serious by the loss of the old enginehouse.

The new layout is a rectangular shaped building, having



Boiler Washout Section, Showing Depressed Drains, Post Cranes, Etc.

straight walls on three sides and the customary inner circle of doors facing the turntable. It is of brick and concrete construction with a timber superstructure of the shed roof type modified to fit the rectangular shape at the corners and where joining into the machine shop and the repair bay monitor. There are 21 stalls, divided into three sections of seven stalls each, one section adjoining and actually being a part of the eight-track repair bay of the monitor type. In one corner of the rectangular house beyond the radial section is located a large machine shop, the boiler and engine room, forges, air compressors and pumps, hot air heating equipment and the offices. A similar corner, although smaller, at the other end has been utilized for the washroom, shower baths, and lavatories, and above this, in a small second floor, are located the lockers. A lean-to adjoining the north wall of the repair bay houses the pumps, tanks and other machinery for a complete boiler washing system.

The repair bay is of the monitor type with a steel superstructure fabricated from floor beams, chords, etc., taken from an old steel bridge across the Susquehanna river. This work was done by company forces, the erection being handled by the bridge gangs. A 15-ton electric traveling crane will be installed in this section of the building, provision having been made in the design and construction for this purpose. The crane bay is 42 feet 7½ inches wide from center to center of posts and runs the full length of this section. A Whiting hoist of 200-ton capacity has also been installed in this section in conjunction with four new concrete pits. Other crane and hoisting facilities consist of a series of six post cranes of 16-foot radius installed at convenient points throughout the house.

The structure is heated by a modern installation of heating coils and blower discharging into a concrete air duct situated below the floor and around the outer circle. This duct is tapped between each two stalls by lines of vitrified clay pipe which carry the heated air to the engine pits. Wherever the enginehouse tracks cross the duct, the upper slab has been reinforced and, in addition, the running rails are carried in a double rail trussed construction.

Electrically Equipped for Economical Operation

The power used in the enginehouse for machine shop, boiler repair and other uses, is purchased from an outside source supplying two-phase energy at 2,300 volts, and 60 cycles which is stepped down to 220 and 110 volts according to needs.

On the inside of the street wall, two 100-watt lighting units are installed between stalls and so arranged that the light beams from each will cross each other, both also being inclined downward to an angle of about 15 degrees from the horizontal. A single unit of this type is mounted on the door posts. Facilities for arc welding are furnished by two Wilson two-man sets delivering sufficient current for four welders through cables tapped at each stall and terminating in a 150-ampere charging receptacle. The welder simply plugs in his welding lead at the proper receptacle, removing it when he has completed his work.

This type welding machine is of great value in the shop.

The majority of the machine tools are belt-driven from an overhead line shaft operated by a 50-horsepower, 220-volt, two-phase motor with a 30-horsepower motor in reserve which can be substituted immediately by throwing on a belt. Two large turret lathes, a blower fan, and a large Ingersoll-Rand air compressor unit have individual motor drives. The latter unit is of the duplex, two-stage, constant speed type with a capacity of 1,574 cubic feet, the regulation of the supply being accomplished by a five-step clearance control which loads or unloads the compressor in five successive steps, according to needs. The motor is a 260-horsepower synchronous motor operating on 2,300 volts. The plant supplies air at 100-pounds pressure for use in the electro-pneumatic interlocking plant, for charging train lines and for various shop and enginehouse requirements.

The air line to the enginehouse stalls is carried on brackets with other pipe lines suspended from the rafters and following around the building 30 feet inside of the doors. There are five distinct lines, aside from the steam line, consisting respectively of a 3-inch air, a 4-inch cold water, a 4-inch filling, a 4-inch washout and a 5-inch blow-off line. Each pit has individual connections.

Shop Equipment

The repair shop is well arranged and well equipped for the work to be performed, which consists entirely of light running repairs. Should heavier repairs be required, a locomotive is sent to the North Shop on the other side of the tracks. At the entrance from the enginehouse to the shop there is a toolroom which serves all the men whether working in the shop or on locomotives. Adjoining this on the same side is a double blacksmith forge with a blower, two anvils and a trip hammer. A 3½-inch bolt threader is also placed on the same side of the room in a convenient position.

Engine lathes are arranged in line along the street side of the shop. These range in size from 14 inches by 6 feet to 36 inches by 20 feet. In front of the lathes is a 60-ton rod press, a double-end emery wheel grinder, a 42-inch drill press, a 4½-foot radial drill, a 28-inch shaper, a 24-inch vertical turret lathe, and a 42-inch vertical boring mill.

List of Shop Tools

The various machine tools installed in the shop include:

60-ton rod press.
4½-ft. Mueller radial drill press.
28-in. Smith & Mills shaper.
20-in. by 3-in. double-end emery wheel grinder.
42-in. drill press.
24-in. Bullard vertical turret lathe.
42-in. Colburn vertical boring mill.
14-in. by 6-ft. Cisco engine lathe.
17-in. by 8-ft. National engine lathe.
18-in. by 8-ft. National engine lathe.
18-in. by 8-ft. National engine lathe.
28-in. by 12½-ft. Boye & Emmes engine lathe.
36-in. by 20-ft. New Haven engine lathe.
3½-in. Adams bolt threader.
Trip hammer.
Buffalo forge blower.
Double blacksmith's forge.
Two anvils.

The Insulation of Boilers and Heated Surfaces*

By Wm. N. Allman

In the insulation of locomotive boilers the one very important feature is to conserve the heat and thereby reduce the loss by radiation to a minimum. The value of such insulation is therefore a matter of importance.

The unit of heat is a B. t. u. There is no insulation that is 100 percent efficient, but the real object of insulation is to prevent to the highest degree the flow of heat to the outside surrounding air from the boiler surface. The conductivity of the material determines the rate of flow with a given difference in temperature. A smaller number of heat units (B. t. u.) will flow through an insulating material with a low conductivity than one with a high conductivity.

The efficiency of an insulating material is expressed by a percentage which represents the percent saving which would be realized by insulating the boiler with such a material over what would be lost if the surface were left bare. The efficiency is then obtained by subtracting the heat loss of the insulated surface from the heat loss of the

*From the Railway Mechanical Engineer.

uninsulated or bare surface, and dividing the result by the heat loss from the bare surface. Expressed as a formula, this would be as follows:

$$E = \frac{U - I}{U}$$

where; U = Heat loss in B. t. u.—bare surface
I = Heat loss in B. t. u.—insulated surface
E = Efficiency of insulation

by referring to Table II the following efficiencies are obtained by interpolation:

	Efficiency	Lb. coal saved per sq. ft. per year
1½ in. thick lagging..........	91.43 per cent	227.6
2 in. thick lagging..........	93.33 per cent	232.4
2½ in thick lagging...........	94.57 per cent	235.5
3 in. thick lagging...........	95.40 per cent	237.5

This shows that even the thinnest insulation will show a large saving by preventing the escape of heat from the surfaces.

TABLE I.

	50 deg.	100 deg.	150 deg.	200 deg.	250 deg.	300 deg.	350 deg.	400 deg.	450 deg.	500 deg.
B.t.u. per square foot per hour	97.5	215.2	360.0	533.0	737.8	978.0	1,269.4	1,614.0	2,050.6	2,590.0

TABLE II

Thickness of insulation	Temperature difference between hot surface and surrounding air— 50 deg.	100 deg.	150 deg.	200 deg.	250 deg.	300 deg.	350 deg.	400 deg.	450 deg.	500 deg.
	Per Cent Efficiencies									
1 in.	80.80	82.36	83.90	85.25	86.48	87.60	88.70	89.64	90.56	91.48
1½ in	86.25	87.40	88.53	89.49	90.37	91.16	91.94	92.65	93.32	93.97
2 in.	89.32	90.16	91.08	91.85	92.53	93.12	93.71	94.27	94.80	95.31
2½ in.	91.19	91.95	92.69	93.32	93.87	94.38	94.87	95.31	95.73	96.14
3 in.	92.55	93.22	93.83	94.37	94.82	95.25	95.67	96.06	96.40	96.75

In Table I the figures represent the loss in B. t. u. which would be expected with bare or uninsulated surfaces for temperatures ranging from 0 to 500 degrees F.

Table II represents the efficiencies of an 85 percent magnesia boiler lagging in thicknesses from 1 inch to 3 inches. It is highly important that material thick enough be applied in order to secure the best results. Another important feature is to cover every square foot of exposed surface. By this is meant the firebox area as well as the shell of the boiler. While a number of railroads have not adopted the practice of covering the exposed area of the outside firebox sheets, it is a mistake to allow them to go uninsulated when it is considered that there is an enormous heat loss which may be saved.

By referring to the figures contained in Table III, it can be readily seen what this loss amounts to in the course of a year.

To determine the amount of heat saved by the application of 85 percent magnesia lagging, we may consider a locomotive boiler carrying a boiler pressure of 200 pounds per square inch, the corresponding temperature being 388 degees F. Assuming an outside temperature of 70 degrees F., we obtain a difference in temperature of 318 degrees F. Referring to Table I, the loss under these conditions would be 1,079.0 B. t. u. per hour per square foot, and for coal having an average thermal content of 13,000 B. t. u. this would equal a waste of 249.0 pounds of fuel as shown in fourth column of Table III for each square foot of surface per year under the conditions as shown; namely, 300 days of 10 hours each.

TABLE III

Steam pressure gage	Steam temperature	Difference between temperature of steam and surrounding air F.	Loss per sq.. ft. per hr. (B.t.u.)	Waste of coal lb. per sq. ft. per year based on 300 days of 10 hrs. each	Number of sq. ft. of surface that wastes a ton of coal in one year
0	212	142	334.0	77.0	26.00
10	240	170	425.0	98.0	20.40
25	267	197	522.5	120.6	16.58
50	298	228	644.0	149.0	13.42
75	320	250	737.5	170.2	11.75
100	338	268	820.0	189.2	10.57
150	366	296	960.0	221.6	9.02
200	388	318	1,079.0	249.0	8.03
250	406	336	1,184.0	273.2	7.32

(Temperature of surrounding air 70 deg. F.)

Note Above figures based on coal having an average heat value of 13,000 B t u.

By the application of 85 percent magnesia sectional lagging with its high insulating value, the major portion of this loss may be saved and converted into useful work, and

Stamping Ohio State Boilers

The Ohio boiler inspection law was amended April 29, 1921; section 1058-17, under the captions "Insurance, Special Inspectors" and "Commissions," which refers to inspectors who are authorized to make inspections for the state of Ohio; and section 1058-23, under the caption "Boilers Which May Be Installed," which refers to the stamping of boilers for use in the state of Ohio.

The original law provided that no person shall act as a general or special inspector unless he had taken an examination before the Ohio Board of Boiler Rules, as specified in the law. The amendment of April 29, 1921, provides that persons may be authorized to act for the state either as a general inspector or as a special inspector if he has passed a written examination approved by the Board of Boiler Rules.

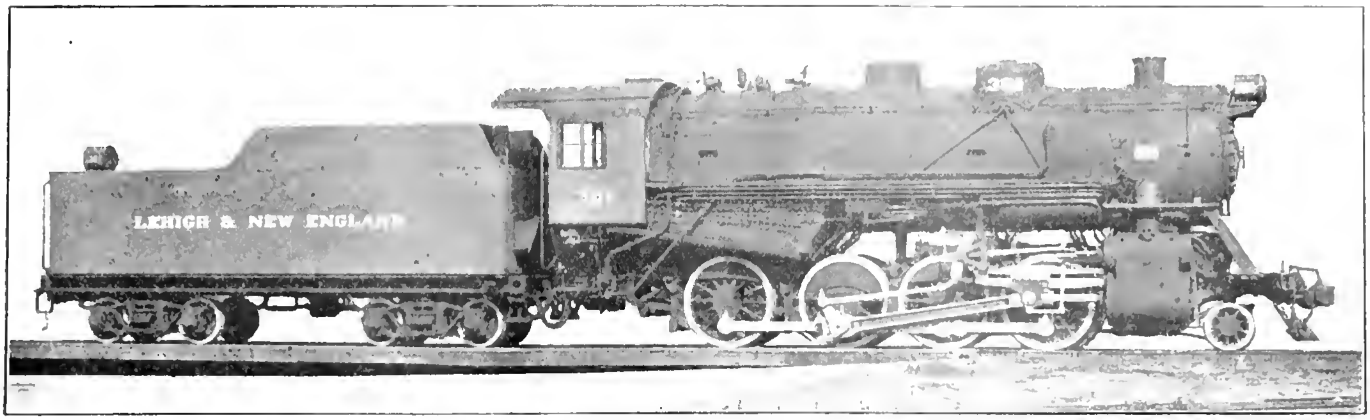
Section 1058-23 of the old law provided that boilers shall be stamped "Ohio Standard." The amended law of April 29, 1921, has stricken out this specific provision and provides that boilers shall be stamped in accordance with the rules formulated by the Board of Boiler Rules.

These two amendments were made in view of placing the boiler inspection department in the position that it could cooperate with the other states by the interchange of inspectors' commissions and the acceptance of boilers stamped other than "Ohio Standard."

The first meeting of the Ohio Board after the required 90-day period had elapsed was August, 1921. At this meeting, it was necessary for the Board to provide for the stamping of boilers, as there were no requirements for stamping at this time, and the following resolution was passed unanimously, covering both the question of inspectors and the stamping of boilers. This rule was not put into effect, due to the unfortunate condition which arose of the changing of the department heads at this same time, but hereafter this resolution of the Ohio Board will be complied with:

"It was animously agreed that our rules be amended Part 3, Sec 1, paragraph 1, page 44, fourth line after the words 'Ohio Standard' insert the words 'or National Board,' and in fifth line, after the words 'Ohio Standard' insert the words 'or National Board.' And in paragraph 9, page 46, after the words 'Ohio Standard' insert the words 'or National Board.' It being understood that this change in no way affects the building and stamping boilers under Ohio Standard requirements as heretofore, but merely permits the use of boilers in this state that bear the approved stamping of the National Board of Boiler and Pressure Vessel Inspectors as outlined in the constitution and by-laws of the National Board.

(*Continued on page* 56)



Consolidation Locomotive Weighing 301,500 lb. and Having a Tractive Force of 68,200 lb.

Powerful Consolidation Locomotive for the L. & N. E.

Well Proportioned Boiler, Unusually Heavy Weight and High Boiler Capacity Feature New Locomotives

Comparatively few locomotives of the 2-8-0 type have been built during recent years for use on American railways. While this was a popular type of freight locomotive for a long period, it has largely been superseded by the Mikado type because of the increased depth of firebox and length of boiler barrel, with correspondingly increased boiler capacity, which can be obtained when a trailing truck is added. However, the Consolidation locomotive is still a highly desirable type where high tractive force combined with low total weight is the important factor as it is where heavy trains, moved at slow speeds, comprise the bulk of the traffic. By careful designing, a boiler of sufficient capacity can be obtained for such service if road clearance does not impose too many restrictions.

Conditions on the Lehigh & New England are especially suited to the operation of Consolidation type locomotives. Since the road is close to the coal mining section fuel is relatively cheap. The vertical clearance of 15 feet 8½ inches gives room above the driving wheels for a boiler of large diameter with a deep throat sheet.

The four Consolidation type locomotives built by the American Locomotive Company which this road has placed in service recently are excellent examples of well-designed engines to meet special conditions. Weighing 301,500 pounds with 279,000 pounds on the drivers, they are the heaviest Consolidation locomotives ever constructed. The Lehigh & New England locomotives have boilers with a larger grate area and more heating surface, which is reflected in the increase of 6,600 pounds in weight.

The height from the rail to the center of the boiler is 10 feet 4 inches and to the top of the stack is 15 feet 8½ inches. The firebox is 126⅛ inches long by 96¼ inches wide, while the height from the bottom of the foundation ring to the crown sheet is 83½ inches at the front and 57¼ inches at the back, which gives a fair firebox volume and sufficient space for the application of a brick arch. There are 301 2-inch tubes and 50 5⅜-inch flues. The total evaporative heating surface is 3,666 square feet, of which 271 square feet is in the firebox. The superheater has 901 square feet heating surface. The rated boiler capacity is 2,420 horsepower, or 88 percent of the cylinder power, which is 2,755 horsepower.

Two of these locomotives are hauling coal trains of 3,500 gross tons from Lansford to Pen Argyl, a distance of 54 miles, part of which is up a 0.5 percent grade, at a speed of approximately 20 miles per hour. Two others are running out of Pen Argyl and handling 690 gross tons up a 2.75 percent grade without difficulty. While no test runs have been made, it has been observed that these locomotives are free steamers, of ample boiler capacity and consume a conservative amount of fuel.

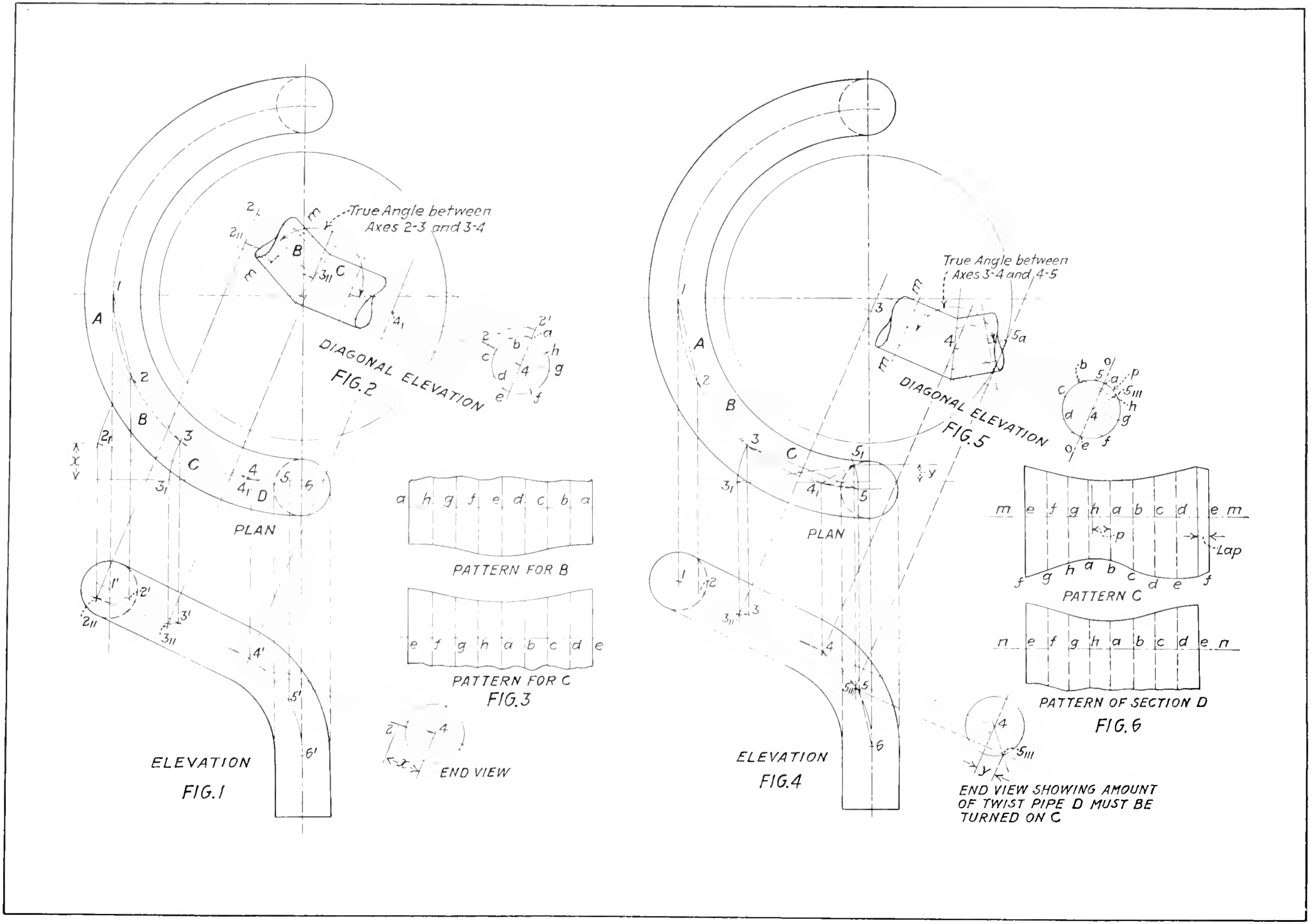
The leading dimensions, weight distributions and proportions of these locomotives are given in the foregoing table.

Dimensions, Weights and Proportions

Type	2-8-0
Service	Drag freight
Total engine weight	301,500 lb.
Total engine wheel base	26 ft. 11 in.
Boiler:	
Type	Straight top
Steam pressure	210 lb.
Fuel, kind	Soft coal
Diameter, first ring, inside	88 in.
Firebox, length and width	126⅛ in. by 96¼ in.
Tubes, number and diameter	301 — 2 in.
Flues, number and diameter	50 — 5⅜ in.
Tubes and flues, length	15 ft.
Grate area	84.3 sq. ft.
Heating surfaces:	
Firebox, including arch tubes	271 sq. ft.
Tubes and flues	3,395 sq. ft.
Total evaporative	3,666 sq. ft.
Superheating	901 sq. ft.
Comb. evaporative and superheating	4,567 sq. ft.
Tender:	
Water capacity	10,000 gal.
Coal capacity	16 tons
General data, estimated:	
Rated tractive force, 85 percent	68,200 lb.
Cylinder horsepower	2,755 hp.
Boiler horsepower	2,420 hp.
Speed at 1,000 ft. piston speed	34 m.p.h.
Coal, rate per sq. ft. grate per hour	106 lb.
Boiler proportions:	
Boiler horsepower ÷ cylinder horsepower	87.9 percent
Comb. heating surface ÷ cylinder horsepower	1.66
Tractive force ÷ comb. heating surface	14.93
Tractive force × dia. drivers ÷ comb. heating surface	911
Cylinder horsepower ÷ grate area	32.7

Smoke Abatement Work Progressing

The smoke abatement work at Grafton, W. Va., conducted by Osborn Monnett and L. R. Hughes, under the supervision of O. P. Hood, chief mechanical engineer of the United States Bureau of Mines, has been brought to a close. Excellent results were obtained, due largely to the hearty cooperation of the Baltimore & Ohio Railroad officials.



Details of Views Used in Developing a Cupola Blast Pipe

Method of Laying Out a Cupola Blast Pipe

Development of Sections of the Pipe With Details of the Various Section Patterns

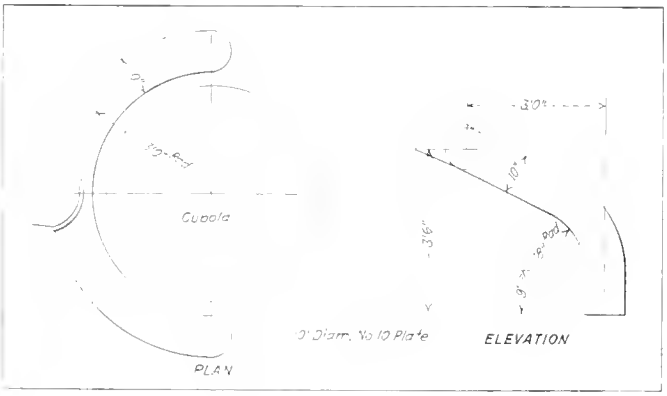
By C. B. Lindstrom

THE problem of developing the double twist occurring in the layout of the cupola blast pipe shown in the accompanying illustration is rather a difficult one and offers an excellent chance to our readers for working out a solution.

In developments of this character there are several steps in the layout that must be made in order to obtain the full view of the connecting pipe sections, the true angle between them and the amount of twist that one section must be turned on the others so as to give the required position of the pipe, otherwise the sections of the elbow would all be in the same plane.

Development of Full Views for Sections *B* and *C*

The center arcs in the plan and elevation, Fig. 1, are divided as required for the number of elbow sections, thus



Problem in Cupola Layout

locating the axes *1-2*, *2-3*, *3-4* and *4-5*. To illustrate the method of developing the full view of sections *B* and *C* and the true angle between them, the axis *3-4* in the plan is revolved about point *4* as a center to bring the line parallel with the front plane. The vertical projection of the line is shown in the elevation at $3_{,,}$-$4'$, which is its true length. In revolving the axis *3-4* also assume that the axis *2-3* is revolved with it, thus bringing its projection in the revolved position at $2'$-$3'$ in the plan and at $2_{,,}$-$3_{,,}$ in the elevation. Extend the line $3_{,,}$-4 in the elevation and at right angles to the line draw an end view of the axes $3_{,,}$-$4'$ and $2_{,,}$-$3_{,,}$. The axis $3_{,,}$-$4'$ in such a view is a point and the line *2-4* for the axis $2_{,,}$-$3_{,,}$. The point *2* is back from the axes *3-4* a distance equal to *x* as shown in the plan.

The diagonal view, Fig. 2, is drawn at right angles to axis $3_{,,}$-$4'$ of the elevation, Fig. 1, thus projectors are drawn respectively from $2_{,,}$-$3_{,,}$ and $4'$. The axis $3_{,,}$-$4'$ is drawn in Fig. 2 perpendicular to these projections and at right angles to this line the end view is reproduced.

The axis of the end view *2-4* is now revolved until it lies perpendicular to *3-4* as shown by its projection 4-$2'$. Point $2'$ is then projected to intersect the projector drawn from the point $2_{,,}$ of the elevation, Fig. 1 to Fig. 2, thus locating point *2* on this line. Connecting the points *2* and $3_{,,}$, $3_{,,}$ and *4*, establishes the full view of the axes. Bisect the angle between the axes and connect the bisector *t* with point $3_{,,}$. The miter lies in the plane of this line. Draw the outline of the elbow sections parallel with their axes and divide the circle in the end view into equal divisions, thus establishing the points *a*, *b*, *c*, *d*, *e*, *f* and *g*. Project these points parallel with $3_{,,}$-4 to intersect the miter line.

Pattern Layout of Sections *B* and *C*

The pattern development for part of each elbow section as it affects their line of intersection is shown in Fig. 3. To complete these patterns it is necessary to lay off the miter lines between the adjoining pipe sections, for example, to finish the pattern *B* the miter between sections *A* and *B* must be laid off, and to finish pattern *C* the miter between sections *C* and *D* must be established and in addition the twist or arc length that section *C* must be turned on its axis with respect to *D* in order to produce the required fall in section *D*; otherwise the two pipes would lie in the same plane. In regard to the upper sections of *A* and *B* this condition does not arise since the pipes lie in a plane perpendicular to the front plane as shown by the projection of their axes in the elevation, Fig. 1.

Figs. 4, 5 and 6 show the correct relationship between pipes *C* and *D*, and how the full view, true angle and twist are obtained. With reference to Fig. 4, plan view, the axis *3-4* is again revolved to lie parallel with the front plane, and axis *4-5* is also revolved with it, occupying the position 4-$5_{,,}$. In the elevation their projections are indicated at $3_{,,}$-4-$5_{,,,}$. An end view is drawn at right angles to $3_{,,}$-4 and on the line drawn from $5_{,,}$ to the end view the distance *Y* is laid off from the center line of the circle. The distance *Y* shows how far the point *5* is back of the line *3-4* as indicated in the plan, Fig. 4. A full view of the pipes' axes is produced by drawing a diagonal elevation, Fig. 5, in the same manner as explained for Fig. 2. The end view is also reproduced in Fig. 5 and the axis *4-5* of this view is revolved to bring it at right angles to the axis *3-4*, thus bringing the line into line *o-o*. The point *5* is then projected to intersect the line drawn from $5_{,,}$ of Fig. 4 to Fig. 5, thus locating the point 5_{a}. Connect points *3-4* and 4-5_{a} and bisect the angle between the lines so as to establish the miter line. About the axes in the full view lay off the outline of the pipes.

The pattern for *C* may now be completed as shown in Fig. 6. The upper part being transferred from Fig. 3. The pattern for *D*, that is, the part adjoining section *C* on the miter can also be laid off from Fig. 5. The amount of twist that *C* is turned on its axis with respect to *D* is equal to the arc length *p* as measured between the points *5* and $5_{,,}$ of the end view, Fig. 5; this distance is located in the pattern for *D* in its relative position.

Cylindrical Pipe and Conical Connection Layout

The principles applied in this example are applicable to any form of oblique cylindrical pipe and conical connections. Considerable study and visualizing are necessary in order to handle layouts of this kind successfully. There are other ways of installing the pipe sections. Some mechanics may produce the true length of pipes and miter and place an additional seam in each of the sections as a slip joint for revolving the pipes until the required twist is secured. This method means additional cost on account of the increased number of joints.

Fig. 1.—Results of a Low Water Explosion in Which the Water was Ten Inches Below the Top of the Crown Sheet at the Time of the Accident

Report of the Bureau of Locomotive Inspection

Boiler Explosions and Casualties During the Fiscal Year Show Great Decrease Over Former Reports

THE outstanding feature of the annual report of the chief inspector of the Bureau of Locomotive Inspection for the year ending June 30, 1922, is that better maintenance of motive power to meet the requirements of the Interstate Commerce Commission rulings has resulted in a marked decrease in the number of accidents and fatalities from failure of locomotives. This is especially true of the boilers and appurtenances where the number of accidents reported—273—is very favorably contrasted with the 342 of the preceding year. Abstracts of the report as presented by A. G. Pack, chief inspector of the Bureau, follow:

The data contained in this report cover all defects on all parts and appurtenances of the locomotive and tender including the boiler, found and reported by our inspectors, together with all accidents as reported under section 8 of the law and the accidents reports act of May, 1910, caused by the failure of some part or appurtenance of the locomotive or tender, including the boiler.

The tables have been arranged so as to permit comparison with previous reports as far as consistent. They show the number of locomotives inspected, the number and percentage of those inspected found defective, and the number for which written notice for repairs was issued because of not meeting the requirements of the law, with the total number of defects found and reported. They also show the number of accidents with number of persons killed and injured, caused by the failure of some part or appurtenance of the locomotive and tender, including the boiler and appurtenances thereof. There is also given by railroads a brief summary of the nature and cause of all accidents, with number of persons killed and injured, as disclosed by investigation.

Number of Locomotives Inspected, Number Found Defective

	Year ended June 30				
	1922	1921	1920	1919	1918
Number of locomotives inspected	64,354	60,812	49,471	59,772	41,611
Number found defective	30,978	30,207	25,529	34,557	22,196
Percentage found defective	48	50	52	58	53
Written notice for repairs served	3,089	3,914	3,774	4,433	2,125
Total defects found	161,734	104,848	95,066	135,300	78,277

Locomotive Boiler Accidents

	Year ended June 30			
	1922	1921	1915	1912
Number of accidents	273	342	424	856
Number killed	25	51	13	91
Number injured	318	379	467	1,005

A summary of all accidents and casualties during the year ended June 30, 1922, as compared with the year ended June 30, 1921 covering the entire locomotive and tender and all of their parts and appurtenances shows a decrease of 15.4 percent in the number of accidents, a decrease of 48.4 percent in the number killed, and a decrease of 11.3 percent in the number injured.

It was apparent during the latter part of the fiscal year that most, if not all, of the carriers were putting forth great efforts to put their locomotives in condition to meet the requirements of the law and the best possible operating condition. Since the law became effective in 1912, 664 boiler explosions resulting in the death of 585 persons, and the serious injury of 1,106 others, have occurred.

During the fiscal year there were 33 boiler explosions re-

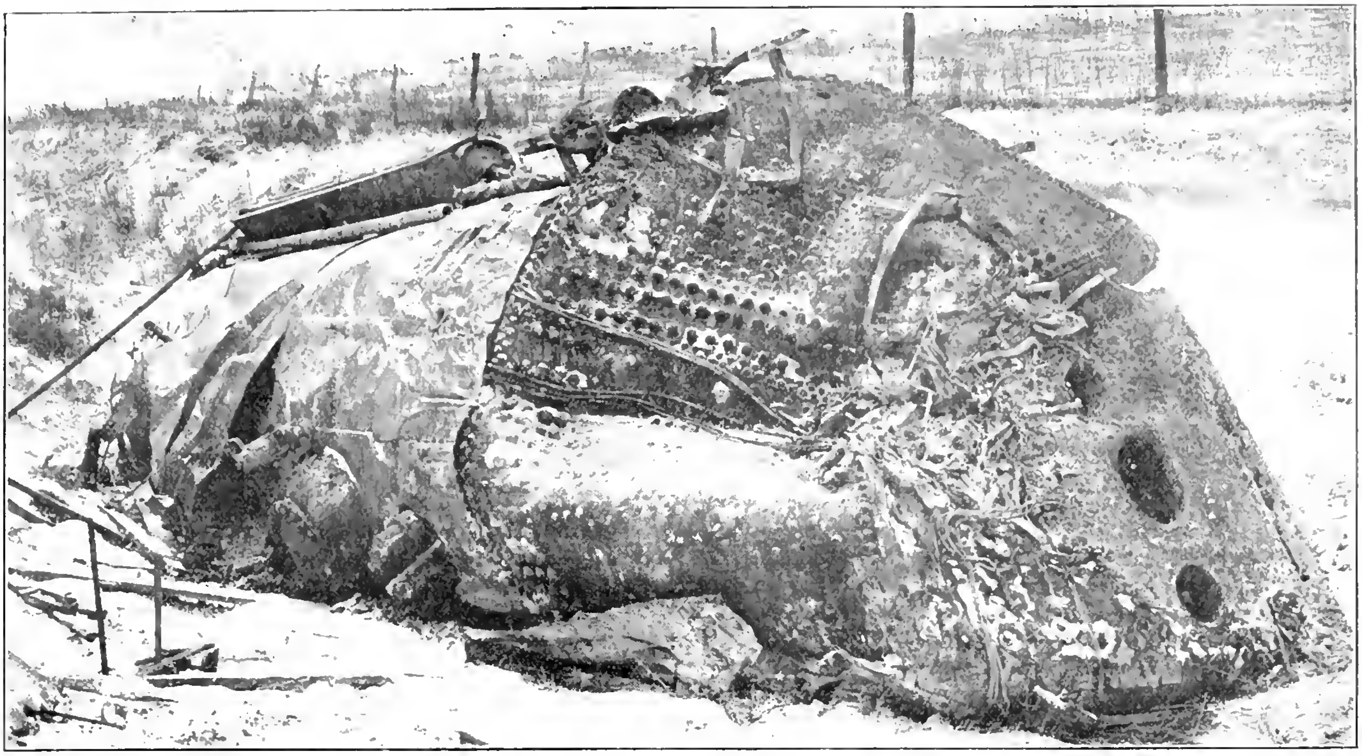


Fig. 2.—Wreck of Boiler Which Landed About 350 Feet from Point of Accident

sulting in the death of 22 persons and the serious injury of 56 others, a substantial reduction as compared with the preceding year. Most of these explosions were caused by overheating of the crown sheet, due to low water. In many instances contributory defects were found, while in others no contributory cause could be assigned. Proper inspection and repair of all parts and appurtenances of the locomotive, including the boiler, are essential to safe and efficient operation, especially the firebox, water feeding and indicating appliances, together with thorough boiler washing as often as water conditions require, and the removal of scale and sediment from the interior of the boiler, which cause heating surfaces to overheat, crack and weaken, and frequently cause failure with serious results.

In my ninth annual report an illustrated report of investigation, covering tests made to determine the action of water in the boiler with its effect on the water-indicating appliances was given. Reference to these tests was also made in my tenth annual report, which investigations established that gage cocks, when screwed directly into the boiler, do not correctly indicate the general water level in the boiler while steam is being rapidly generated and escaping from the boiler. It was recommended that a suitable water column, to which should be attached three gage cocks and one water glass, be applied to the boiler, with an additional water glass applied on the left side or boiler backhead. It is felt that these recommendations together with the increased attention given to the water-indicating appliances as a result of our report, and our personal efforts have largely tended to decrease the number of so-called "crown sheet failures" or boiler explosions. Water columns, as recommended, have been applied to practically all new locomotives constructed during the past two years, and on a large number of old locomotives on most of the large railway systems throughout the country, and it is gratifying to advise that, with very few exceptions, the mechanical and other officials have accepted these recommendations and are carrying them out in varying degrees, and it is hoped that they will be carried out in the near future by all carriers without the necessity of being compelled to do so by an order of the commission.

Accurate knowledge of the general water level in the boiler is essential under all conditions of service to safe and economical locomotive operation.

Investigation of accidents during the year, where the fusion or autogenous welding process was involved, supports our position previously taken that the process has not yet reached a state of perfection where it can be safely depended upon in boiler construction and repair where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown-sheet seams where overheating and failure are liable to occur, nor its excessive use in repairing long and numerous cracks in side sheets.

Grate Shaking Apparatus Involved in Accidents

A large number of accidents have been caused by defective grate-shaking apparatus, the majority of which were caused by the shaker bar not properly fitting the fulcrum lever. This condition on many roads has been brought about because of no standard design being maintained, making such parts interchangeable. We have records of many such accidents where permanent and fatal injuries resulted. Therefore it should be required that all carriers adopt a standard whereby shaker bars can be made interchangeable on all of their locomotives with a proper fit.

So that the chief operating officers of the carriers might be kept informed of the condition of their locomotives, as disclosed by our inspections, a transcribed report showing in detail the defects found has been sent to them each month; also informing them of the locomotives for which special notice for repairs was issued as required by section 6 of the law, because of defects constituting violations thereof.

During the year 148 applications were filed for extension of time for removal of flues, as provided in rule 10. An investigation disclosed that in 17 of these cases the condition of the locomotive was such that no extension within the purpose and intent of the law could be properly granted. Fifteen were in such condition that the full extension requested could not be authorized, but an extension for a shorter period, within the limits of safety, was allowed. Six extensions were granted after defects disclosed by our investigation had been repaired. Nine applications were withdrawn by the carriers for various reasons, and the remaining 101 were granted for the period requested.

In accordance with rule 54 there were filed 1,508 specification cards and 5,519 alteration reports necessary in determining the safe working pressure and other required data for the boilers represented. These specification cards and alteration reports have been carefully analyzed in order to determine whether or not the boilers covered were so constructed as to be in safe and proper condition for service, and that the stresses were within the limits required. Numerous discrepancies were found and corrective measures taken immediately.

Work of the Inspectors

By request of the commission, inspectors of this bureau spent 200 days in special work during the year, and during the fiscal year 1921 spent 962 days in connection with the transportation act, 1920, and the interstate commerce act, the expense of which was borne from the general appropriation which materially assisted us in avoiding a deficiency in the appropriation made to carry out the purpose of the locomotive boiler inspection law as amended.

In order to keep within the appropriation it has been necessary to curtail materially the travel of our inspectional force in the performance of their required duties, and to curtail the stenographic, clerical, and other office assistance furnished the chief inspector and his assistants to the detriment of the service.

To adequately carry out the purpose of the law a material increase in the number of inspectors and a material increase in the appropriation should be made so as to fully perform the duties required.

No formal appeal from the decision of any inspector, as provided in section 6 of the law, was filed during the year,

Fig. 3.—Firebox after Explosion, Showing Crown and Flue Sheets Folded Back Against Door Sheet

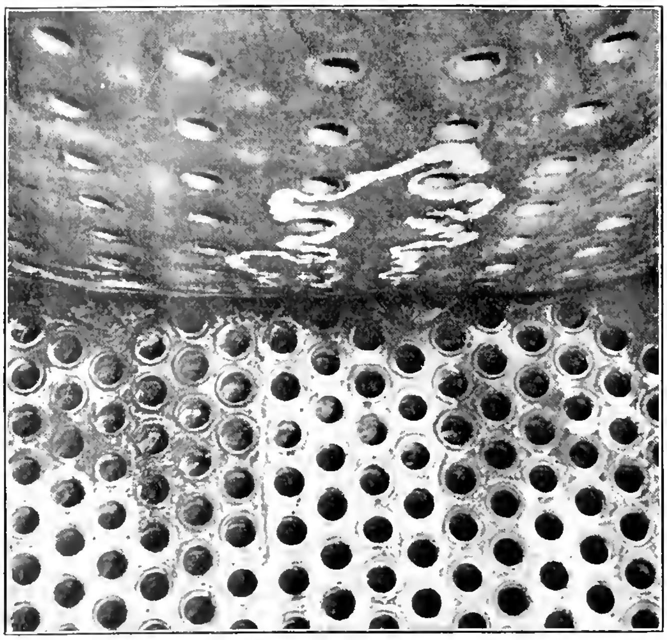


Fig. 4.—Crown Sheet Failure, Showing Sheet Pocketed to Depth of 14 Inches

which again demonstrates that good judgment was exercised by them in the performance of their duties.

In my ninth and tenth annual reports certain recommendations were made for the betterment of the service as required by section 7 of the act. Some of these suggestions are in part as follows:

I am convinced from experience of the necessity and wisdom of these recommendations. Therefore they are respectfully renewed and reasons therefor given:

First. That the act of February 17, 1911, as amended, be further amended to provide for additional inspectors and increased compensation, and to provide for a sufficient appropriation to adequately carry out the purpose of the law.

That all locomotives not using oil for fuel have a mechanically operated fire door so constructed that it may be operated by pressure of the foot on a pedal or other suitable device located on the floor of the cab or tender at a proper distance from the fire door, so that it may be conveniently operated by the person firing the locomotive.

This recommendation is based on the results of many investigations of boiler failures of such character as to permit the steam and water contained in the boiler at the time of the accident to be discharged into the firebox, many times being directed toward the fire door.

That a power-reversing gear be applied to all locomotives and that air-operated power-reversing gear have a steam connection with the operating valves conveniently located in the cab, so arranged that in case of air failure steam may be quickly used to operate the reversing gear.

That a power grate shaker be applied to all coal-burning locomotives.

This appliance has been in use for a number of years and tried out very thoroughly, and was adopted as standard by the standardization committee of the United States Railroad Administration, composed of 14 very prominent superintendents of motive power and railroad mechanical officials.

That all locomotives be provided with a bell so arranged and maintained that it may be operated from the engineer's cab by hand and by power.

That all locomotives where there is a difference between the readings of the gage cocks and water glass of 2 or more inches under any condition of service be equipped with a suitable water column, to which shall be attached three gage

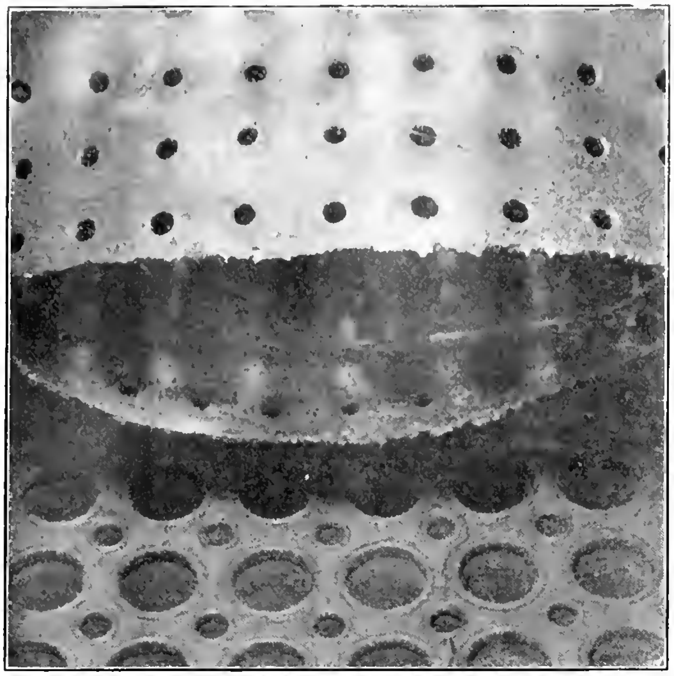


Fig. 5.—Failure of a Welded Crown Sheet Patch

cocks and one water glass, with not less than 6 inches, preferably 8 inches, clear reading and one water glass with not less than 6 inches, preferably 8 inches, clear reading on the left side or back head of the boiler.

Water glasses should be so located, constructed, and maintained that they will register the approximate general water level in the boiler under all conditions of service and show within 1 inch a corresponding level, and so maintained that the engineer and fireman may have under all conditions of service a clear view of the water in the glass from their respective and proper positions in the cab.

Gage cocks should be located within easy reach of the engineer from his proper position in the cab while operating the locomotive, extension handles to be applied if necessary to accomplish this. All gage cocks to be supplied with suitable nipples that will directly discharge into a properly constructed and located drain or dripper that will convey the discharged water to near the cab deck or floor, nipples to be not less than one-half inch nor more than 1 inch above the dripper or drain and kept in correct alignment.

Gage cocks and water glasses are now universally used for gaging the water level in the boiler; and since the two appliances located on the same boiler do not show a corresponding level under operating conditions it is clear that one or the other is incorrect and therefore misleading.

Investigations have clearly established that gage cocks when screwed directly into the boiler do not correctly register the proper water level over the crown sheet. It is very important that at least two appliances attached separately be employed for this purpose so as to form a double check and so as to have one appliance in case of failure of the other while on the road and away from points where repairs can be made.

Should any other appliance than the water column or water glass be invented which will safely and correctly indicate the water level in the boiler, due consideration can be given. The requirements herein recommended should be complied with the first time the locomotive is shopped for classified repairs, as established by the United States Railroad Administration.

The accompanying illustrations Figs. 1, 2 and 3 show the result of a boiler explosion due to low water, which caused the death of three persons and the serious injury of another, while running at an estimated speed of 35 miles per hour. The line of demarcation indicated that the water was 10 inches below the highest part of the crown sheet at the time of the accident. The boiler appurtenances were damaged to such an extent that their previous condition could not be determined.

Accidents and Casualties Resulting from Failures of Locomotive Boilers and Their Appurtenances

Part or appurtenance which caused accident	1922			1921			1920			1919			1918		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
Air reservoirs	3		3	1	..	1	2	1	2	2	..	2	5	..	7
Aprons	11	..	11	16	..	16	8	..	8	5	..	5	5	..	5
Arch tubes	4	.	5	5	..	5	9	1	15	7	2	9	9	..	16
Ash-pan blowers	7		7	5	.	5	6	1	5	11	1	10	7	..	7
Blow-off cocks	16	..	16	14	.	14	15	..	15	4	..	4	17	1	18
Boiler checks	4	..	4	7	1	7	5	..	6	4	..	4	13	..	14
Boiler explosions:															
A. Shell explosions	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..
B. Crown sheet; low water; no contributory causes found	13	15	23	20	19	26	24	22	35	31	26	46	34	15	61
C. Crown sheet; low water; contributory causes or defects found	14	6	27	33	24	52	35	19	46	34	13	63	51	17	82
D. Firebox; defective staybolts, crown stays, or sheets	5	1	5	1	2	..	2	..	2	2	..	3	5	..	6
E. Firebox; water foaming	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Dome caps	..	..	..	..	..	..	..	..	..	..	..	..	1	..	1
Draft appliances	6	.	9	8	..	9	1	..	1	2	..	4	5	..	5
Fire doors, levers, etc.	2	..	2	8	..	8	11	..	11	7	..	7	6	..	6
Flues	28		32	32	1	35	45	..	52	33	1	39	40	..	47
Flue pockets	1	1	.	1	1	..	..	..	..	2	..	2	2	..	2
Gage cocks	2	..	2	..	..	..	2	..	2	..	..	..	1	..	1
Grease cups	3	..	3	7	..	7	10	..	10	3	..	3	1	..	2
Grate shakers	49		49	85	..	85	108	..	109	37	1	36	39	..	39
Handholds	12	1	11	19	..	20	15	1	14	16	1	15	15	1	14
Headlights and brackets	2	.	2	8	2	6	9	1	9	4	.	5	9	..	10
Injectors and connections (not including injector steam pipes)	21		24	15	2	13	23	..	27	21	..	22	23	..	24
Injector steam pipes	9	..	9	15	.	17	23	1	29	14	..	20	16	..	18
Lubricators and connections	9	..	9	12	..	12	14	..	15	11	..	13	12	..	12
Lubricator glasses	3	..	3	3	..	3	17	..	17	9	..	9	12	..	12
Patch bolts	..	..	..	..	..	..	..	..	..	..	..	..	2	..	3
Plugs, arch tube, and washout	12	1	19	15	..	18	28	..	40	30	1	34	14	2	19
Plugs in firebox sheets	2	.	3	2	..	2	1	..	2	2	1	1	3	..	3
Rivets	..	..	..	4	..	5	..	..	..	2	..	2	3	..	3
Safety valves	..	..	..	..	..	..	..	..	..	1	..	1	..	..	..
Staybolts	6	..	8	..	..	..	2	2	1	2	..	2	6	..	8
Steam piping and blowers	9	..	11	9	..	9	18	1	19	8	..	11	10	..	11
Superheater tubes	..	..	..	1	..	2	4	..	6	1	..	1	3	..	4
Water glasses	19	..	19	25	..	25	32	.	32	26	..	26	20	..	20
Water-glass fittings	6	.	6	2	.	2	4	..	4	4	..	4	11	1	10
Miscellaneous	61	..	61	91	2	117	87	2	86	35	2	35	32	..	43

Year ended June 30

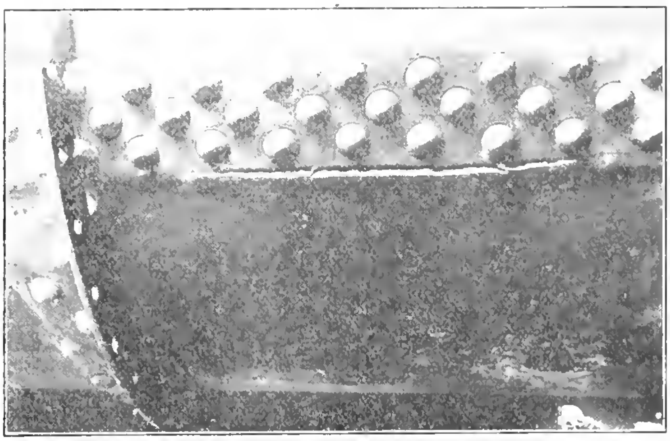


Fig. 6.—Rupture of Patch Applied to the First Course Longitudinal Seam in the Boiler Barrel

Fig. 4 shows a crown-sheet failure, due to low water. The crown sheet was overheated practically its entire length, and pulled away from 297 radial stays, pocketing to a depth of 14 inches. The gage cocks were screwed directly in the back head, and the bottom gage cock entered the boiler through a tee iron, directly behind and close to a brace lug, while the top gage cock entered the boiler through the webb of the tee iron.

Investigation disclosed that this locomotive was permitted to go into service with water foaming badly, which should not have existed had the boiler been washed as often as water conditions required; a requirement of rule 45.

Overheating of Crown-Sheet

In Fig. 5 is shown a crown-sheet failure, due to overheating, resulting in serious injury to four persons. A patch had been applied in the crown sheet, with seams autogenously welded, and the transverse seam between the patch and crown sheet failed for its entire length of 48 inches. The line of demarcation, caused by overheating, showed that the water at the time of the accident was about 1⅜ inches below the highest part of the crown sheet.

The water glass had been broken two days prior to the accident and the locomotive used without repairs or replacement. Evidence showed that the boiler was very dirty and the water foaming badly prior to the accident. Of 58 crown stays which pulled away from the sheet 22 were practically without threads either on the stay or in the sheet. The lowest reading of the water glass and the lowest reading of the gage cock were only 1¾ inches, respectively, above the highest part of the crown sheet.

Had the law and rules and our previous recommendations in connection with the water glass and gage cock applications and autogenous welding in the so-called "low water zone" been properly complied with, it is entirely possible that this accident would have been avoided.

Fig. 6 shows a rupture which occurred in the barrel of a boiler carrying 180 pounds steam pressure, causing the serious injury of one employee. The rupture occurred in a patch which had been applied to the first course longitudinal seam, creating an aperture 22 inches in length, with a maximum width of three-sixteenths inch. The patch was five-eighths inch in thickness and was applied with a triple-riveted lap-joint seam, and had been offset where it joined the original sheet.

The rupture was the final result of an old progressive

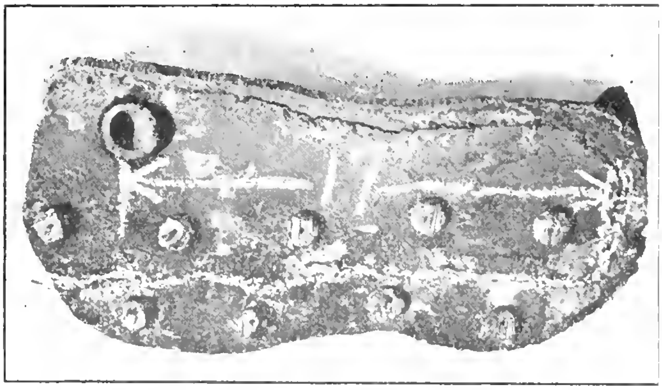


Fig. 7.—Back Head Patch Which Failed with Serious Results

crack, 41½ inches in length, developing from the interior of the boiler just below the bottom line of rivets and in the offset portion covered by the lap of the original sheet.

The breathing action of the boiler evidently caused this patch to crack where it was offset, leaving only one-sixteenth inch material intact just prior to the failure.

This accident demonstrates the necessity for great care in ... of the interior of the boiler at required intervals. ... the results of this failure were ... the

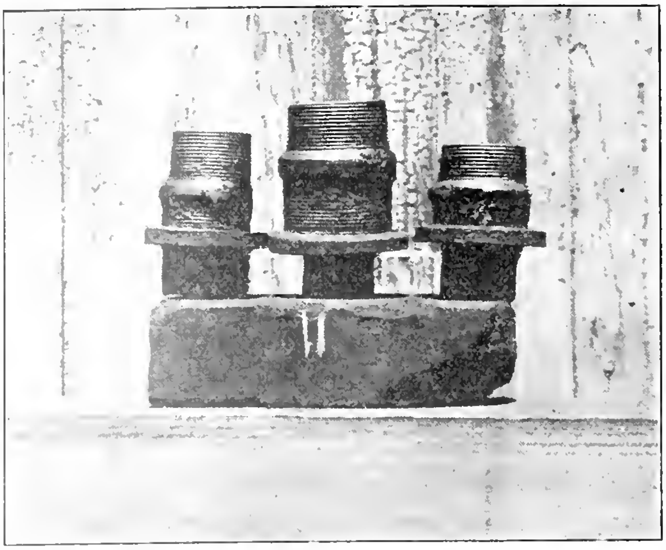


Fig. 8.—Graphite Accumulation on These Plugs Prevented Them from Being Tightened in Their Seats

suddenly failed for a distance of 17 inches, seriously scalding the engineer, compelling him to leave the cab of the locomotive through the side window while hauling a passenger train at an approximate speed of 35 miles per hour. The fireman escaped injury by leaving the cab through the left front window. The conductor noticed that the train was passing the station where it should have stopped, and pulled the emergency valve, thus applying the brakes and stopping the train.

Washout Plug Defects

Fig. 8 shows three washout plugs on which graphite and other substances had been allowed to accumulate, forming shoulders which prevented the plugs from being properly screwed in and tightened.

Since the law was enacted 194 accidents, resulting in the death of 10 persons and serious injury of 247 others, have been caused by washout and arch-tube plugs blowing out. In all cases washout and arch-tube plugs should be maintained and properly fitted so that they can be screwed in to prevent leakage and the possibility of blowing out while under pressure.

The locomotive from which these plugs were removed had special notice for repairs issued, as required by section 6 of the law.

Properties of Boiler Plates

Tests have been conducted recently by the United States Bureau of Standards, Washington, on the properties of various grades of boiler plate through the range of 20 to 465 degrees C. The tests have been conducted to determine the effect of blue and cold work, variations in the rate of loading, elastic overstrain, and the subsequent behavior of over-strained steel with time. The result of this work has been published in Technologic paper No. 219.

The paper describes the special apparatus employed in making high temperature tensile tests and the difference in behavior of steel noted at various ranges. It was found that the proportional limit of several grades of plates does not decrease with the first rise in temperature, but is either maintained at about room temperature or increased before the final decrease occurs. The increased strength produced by rolling cold or blue heat is maintained through a considerable temperature range, but these effects may be removed by annealing. Other tests are described in detail in this ...t.—*Iron Trade Review.*

The Design and Proportioning of Flue Sheets

Free Circulation of Water of More Importance in the Design than Providing Maximum Flue Heating Surface

By C. E. Lester

One of the greatest difficulties met with in the design of boilers is the proportioning of the flues and parts connected with them to meet given requirements. The necessity for a fixed ratio of heating surface to grate area and boiler capacity causes limitations that ofttimes adversely affect the efficiency and economical operation of flues.

For example—the theoretical necessity for flue heating surface requires the close spacing of flues and the utilization of the greatest area possible of the back flue sheet embraced between the crown and side sheets and above the throat sheet for the installation of flues.

Spacing of Flues

Generally, flues are spaced on diagonal lines which permits of close spacing and gains the widest ligament possible between flues. This, however, narrows the vertical space between the flues retarding the free passage of precipitating solids to the belly of the boiler and hastens the time when such an accumulation affects the passage of the heat to the water. This, naturally, somewhat shortens the period of economical operation. Intimate knowledge of many instances when locomotives steamed freely with over 10 per cent of the flues stopped up, mediocre fuel, and under various traffic and grade conditions, leads the writer to express the conviction that in various types of locomotive boilers flue heating surface should be sacrificed for wider ligaments between flues. This will allow freer circulation and freer passage of solids in the water and by the bottom flues farther from the grate line.

An Example of Accumulation of Solids

I have in mind among other locomotives of various types one particular series of locomotives of the 2-10-2 type equipped with a special brick wall that were very free steamers under even the most adverse conditions of service, yet by reason of the short distance between the grates and the bottom flues there were always from 50 to 100 flues stopped up in spite of numberless changes in the draft appliances and thorough flue cleaning. Such conditions while apparently not affecting the efficiency of the locomotives from a haulage viewpoint did materially affect the cost of maintenance, as they were prolific sources of trouble for the boilermakers by reason of the conditions mentioned. A change of flue sheet design leaving out about 50 flues would not have affected the steaming qualities of the locomotives and would have materially lessened the leakage and other troubles.

In design recognition, in a degree, has been taken of the necessity of keeping flue holes away from the back flue sheet flange, particularly at the top; that is, placing the holes a sufficient distance from the flange to prevent, or, at least, to retard the cracks from the flue holes to the flange. In the more modern types the radius of the sheet flange has been increased from 1/2 inch to 2 inches in an effort to prevent cracks, yet they are still in evidence though not to the extent that they were with the sharper flanges. It seems that the larger radii gives the best results.

The accompanying illustrations show some practices in back flue sheet design that have been and still are with various minor modifications, deemed good. Fig. 1 illustrates a radius that is four times the thickness of the back flue sheet and the top of the top flue set 1/4 inch below that. This is believed to be good practice yet without wishing to appear radical I favor still greater radii for back sheets of large high pressure boilers.

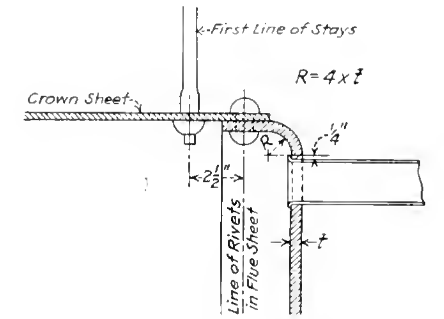


Fig. 1.—Good Practice in Flue Sheet Design

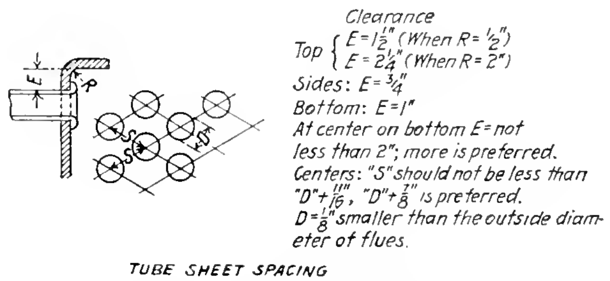


Fig. 2.—Sharp Flanges Troublesome to Boiler Makers

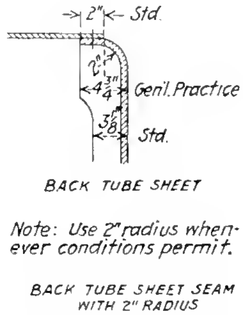


Fig. 3.—Dimensions for Flange Depth

Sharp Flanges Not Good Practice

Fig. 2 illustrates a sharp flange that is found mostly in very small or old boilers. This practice has nothing to commend it with the exception of allowing the designer to stick in another row of flues across the top. It actually is a trouble maker for boiler makers.

This section also illustrates the side and bottom limits as well as the minimum and maximum flue hole centers. It is felt that if flue heating surface could be sacrificed enough to increase the width of this ligament to at least 1/4 inch that better flue service would be obtained and the evaporative efficiency would not be lessened materially. The fact that flue heating surface is but about 20 percent the value of the firebox heating surface prompts the expression that a few flues less would not be noticed.

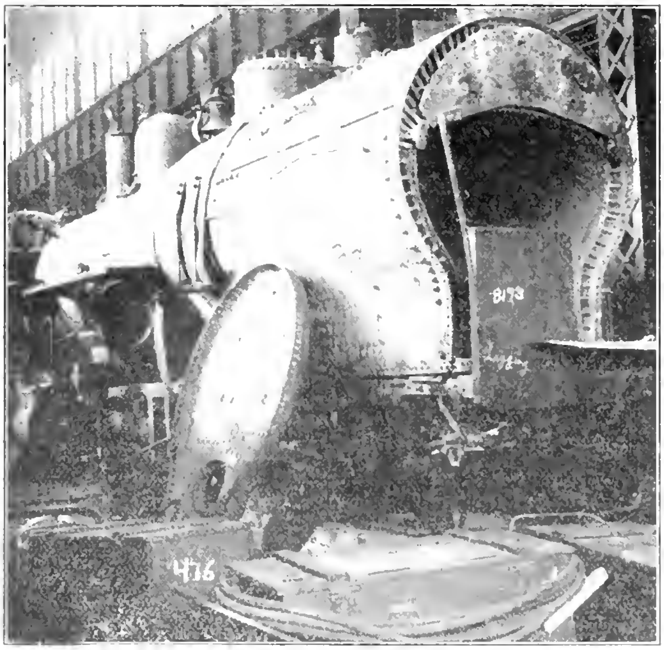
Fig. 3 simply shows some very acceptable dimensions for flange depth and rivet line of a back flue sheet with a 2-inch radius flange.

This has been used to good advantage on recent locomotives.

Burning Out Staybolts with Gas

STRIKING results in burning out bolts of all kinds with the oxyacetylene torch are now being accomplished, and, on boiler work such as shown in the illustration, the cutting torch proves especially valuable. In the shop where the photograph was taken, one operator specializes on this work. In burning out staybolts, he first melts a hole in the center of the bolt a little deeper than the thickness of the boiler sheet, then giving the hand and torch a rotary motion. This completely cuts off the staybolt inside the sheet leaving a conical end on the cut-off bolt. The shell of the old bolt, left in the sheet, can then be carefully removed with a hammer and chisel without damaging the thread. In the case of rivets, experience has shown it best to burn a good sized hole completely through the rivet, then driving out what is left of the head and shell, releasing the sheets.

In an actual test the operator referred to has burned out 253 rigid staybolts in 66 minutes, or at a rate of almost four a minute. In another case where firebox side sheets were



On Jobs Like This the Gas Cutting Torch for Burning Out Rivets and Staybolts Saves Money

to be renewed, 1,058 flexible staybolts and 392 rivets were burned out in 15 hr. 10 min. by this one operator. Considerable skill is needed in the manipulation of the torch, in order not to burn the tip or run into the sheets or mud ring, especially when burning out long bolts or rivets. It is said that frame bolts up to 8 in. long can be burned out with a torch, the length of bolt removable in this manner depending upon its diameter. The torch is also used to cut out superheater flues, a set of 43 flues being cut out in 55 min. by one operator, whereas it takes about 2½ hours with the more common machine method. Other operations economically performed include cutting out front-end netting plates, and ashpan sheets. Flue sheets can be scarfed at the rate of 12½ ft. an hour.

The illustration shows a method of renewing fireboxes by removing the back head, made feasible largely by the development of gas cutting of staybolts and rivets. The particular advantage of this method is that the complete firebox can be removed without taking the boiler from the frame, or drilling the outside wrapper sheet rivets and removing the complete boiler back end, as is sometimes done. This effects an important saving in time and labor.

In the case illustrated, the rivets and staybolts holding the back head, together with all other rivets and staybolts holding the firebox were quickly and economically burned out with the gas cutting torch. A total of 1,670 rigid and flexible staybolts on this entire job were burned out by one man in 16 hours. There are 278 rivets in the back head, 270 in the mud ring and 93 rivets in the flue sheet, making a total of 641 rivets burned out in 12 hours, also by one man. A comparison of these figures with the time required to cut out rivets and staybolts by former methods will quickly show the advantage of the gas cutting torch for this work.

Investigation of Strength of Welded Pressure Vessels

ONE of the many difficult problems confronting the Boiler Code Committee of the American Society of Mechanical Engineers in its effort to draw up satisfactory codes governing the construction of unfired pressure vessels was that of welding. Rules applicable to riveted constructions do not always apply to fabrication by welding.

The problem is seriously complicated because of the small amount of scientific data upon which to base proper requirements for safety without placing unjust restrictions on the use of welding. Wide differences of opinion prevailed not only among the members of the committee, the insurance companies and inspectors, but also in the industry itself.

Acceptable Tests Developed

A hydrostatic and hammer test was finally proposed for determining whether a vessel was safe for the purpose designed. The American Bureau of Welding, which is the advisory committee on welding research for the American Welding Society and the National Research Council, organized a pressure vessel committee to cooperate with the Boiler Code Committee in determining the adequacy of the test proposed. Eight manufacturers placed at the disposal of the committee some 40 tanks and enough funds to carry on the work. These tanks have been tested to destruction by the U. S. Bureau of Standards.

The shells of most of the tanks were 6 feet long and 2 feet in diameter, and made of ⅜-inch mild steel plate. Both electric and oxyacetylene welding were used. The hydrostatic and hammer test developed that the welded pressure vessel, according to the regular formulæ for working pressure, has a factor of safety of about 6.

A remarkable feature of this undertaking is the rapidity of accomplishment. The first meeting of the committee was held in New York on August 17, and a plan outlined. The tanks called for in the program were immediately built by manufacturers distributed widely (one of them on the Pacific Coast), and shipped to the Bureau of Standards in Washington. Most of the tanks arrived by the first of December. Under the supervision of Dr. H. L. Whittemore, Chief of Section VII-1, Physical Tests of Structural Materials Division, who is also chairman of the committee, testing was started December 4 and carried on continuously to January 10. Many visitors, including members of the Boiler Code Committee, insurance inspectors, tank manufacturers, American Welding Society and National Research Council, have witnessed tests. A report is being compiled and will soon be published. This program including tanks, testing and incidentals, involved a sum of $15,000.

The manufacturers cooperating in this work are: York Manufacturing Company, Pfaudler Company, Elyria Enameled Products Company, Union Carbide and Carbon Corporation, DeLaVergne Machine Company, Coast Culvert & Flume Company, Brunswick-Kroeschell Company, and Vilter Manufacturing Company.

Recent Improvements in Watertube Boiler Design

British Engineers Develop Two New Types of Watertube Boilers in which Water Circulation is Greatly Increased

By T. Sington

ENGINEERING developments, improvements and extensions during recent years have resulted in a demand for greater boiler efficiency, as the older types, although admirably suited to former conditions, have not been equal to the most recent demands for greater steam pressures and higher superheat. Vastly increased wages in Europe due to the war, as well as alarmingly higher prices for coal and other necessary materials have literally compelled engineers to seek for relief in boiler improvements. Many factors have combined to necessitate further steps in the evolution of boiler design; larger electric power stations, greater size, an increased speed of shipping, electrification of railways and so on.

The most recent boiler improvements, briefly described below, are an attempt to provide for these requirements. The improvements do not constitute new boilers, or types; the principles on which they are based have been known for some years and have stood the test of experience. The new steam generator is a modified watertube boiler of which in its improved form there are two types, one with a longitudinal drum and the other with a cross drum; the former is suitable for smaller sizes and the latter for boilers of larger capacity; both are of the sectional header class, the main distinctive features common to both are the downcomer pipes, the reservoir mud drum and the enlarged nipples, also the straight headers.

To quote an expert on boiler design, the headers are straight, rectangular and larger in area than usual by forty percent, affording freer circulation to the steam and water and making cleaning easier than in the case of the sinuous type. As it is not necessary to stretch the material in construction to the same degree as in the sinuous headers, the thickness of the straight headers is more uniform; moreover, it is a simple matter to make the joints between the straight headers airtight. The headers are connected to the drums by nipple tubes, which are 28 percent larger in area than is usually the case, a point which increases the safe and steady steaming capacity of the boiler.

Mud Drum Design

The reservoir mud drum has to be considered in connection with the downcomer pipe, which leads to it from the circulation drum. The function of this pipe—one, two or more are fitted according to the evaporative capacity of the boiler—is to secure positive circulation from the main steam and water drum through the mud drum to the headers and tubes. Usually the internal diameter of the downcomer pipe is about eight inches so that the risk of choking by deposit or incrustation is altogether negligible. In the position it occupies it is not subjected to excessive temperature. Each pipe is solid drawn and is flanged at each end so that it may be bolted to the stand pipe and riveted to the steam drum. This arrangement enables the downcomer pipe to be readily detached if necessary.

Water Freely Circulates in Mud Drum

By means of the downcomer pipe all the water is circulated through the mud drum, which efficiently collects and retains the deposit, which would otherwise be distributed through the headers, or to the steam generating surfaces; the drum is of ample dimensions and is readily accessible for cleaning. The water flows from it through short connecting nipples to the back headers, providing a full supply of water to the bottom rows of tubes first; moreover, the flow is in the right direction along the tube, upwards and outwards.

As the tubes nearer the fire play the most important part in steam generation, the correct mode of water supply is of great importance. The improved boiler, it is asserted, surpasses all others as regards this point. In the longitudinal drum type the headers are connected to the drum by curved nipples directly expanded into holes in the drum. These holes are compensated for by a doubling plate, thus avoiding the weakness of a cross-box with a large opening in the shell and a considerable flat surface. To facilitate the removal of soot by blowers the watertubes are only staggered about one inch.

The outstanding result of the general design of the improved boiler, to again quote an expert, is that with large downcomer pipe, the large nipples and straight headers, a free, natural and positive circulation is secured. This feature, combined with the ample steam and water capacity, enables the boiler to respond readily to overload demands. The renewal and the cleaning of tubes are not only exceptionally simple on account of the tubes being straight and easy of access, but the necessity for either is reduced by the peculiarities of circulation mentioned above. Expansion and contraction stresses are also greatly minimized, as all parts liable to considerable changes in dimensions are free to adjust themselves to an unusual degree.

Electric Boiler for Heating Trains

A RECENT paper, presented by Sir Vincent Raven before the Institution of Mechanical Engineers in England, describes an electrically heated steam boiler designed by C. Orme Bastian, for the heating of trains on the electrified section of the North Eastern Railway, England. The problem to be solved arose in connection with the heating of rolling stock which passes from ordinary steam track over an electrified section. In the United States, this is usually done with an oil-fired boiler to provide the necessary steam. The equipment designed by Mr. Bastian has been entirely successful and it would not be surprising to find some similar method of train heating eventually substituted for the oil-fired boilers in this country.

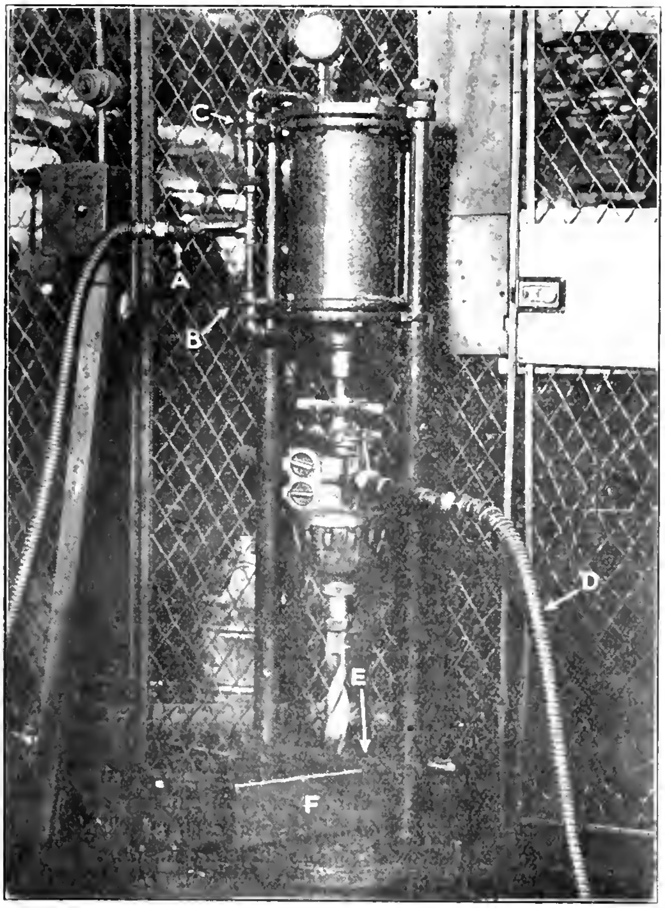
The electric boiler installed on the new North Eastern locomotive is 3 feet 4 inches in diameter and 3 feet 4 inches long; it is capable of supplying enough steam for the largest train handled in ordinary service.

The construction of the boiler is extremely simple, being of the ordinary multi-tubular type, without any of the usual accessories. There are 144 tubes, into each of which is introduced a quartz tube, 3/4 inch in diameter; inside of each tube is a close spiral heating element of resistance wire. Wound in this way the wire is free from the risk of developing hot spots; something which must be carefully guarded against under the special conditions. So satisfactory is the design claimed to be that the firm of Bastian & Allen is willing to build electric boilers even on direct current lines up to 3,000 volts. Simple but adequate means are taken to insure satisfactory connection with the elements and to prevent damage to the quartz tube by vibration. The tube is mounted on a mica washer in the end of a hollow porcelain terminal, which is held by spring pressure to the terminal plate of the boiler. There are cases where steam has to be applied at places remote from any point where a fuel-fired boiler can be conveniently or safely placed. Under conditions in which the electrically fired boiler can be placed where it is needed, thereby eliminating all pipe losses, it may prove the most economical as well as the handiest solution. The electric boiler has proved satisfactory under conditions of vibration and shock.

Air Motor Testing Device

In view of the large number of pneumatic motors used in railroad shops it is essential that they be kept in good repair and operating as near as possible at maximum efficiency, otherwise there will be a large aggregate loss of time and effort in doing the work.

Various forms of brakes have been developed for testing air motors but results obtained with this form of apparatus are not wholly reliable since the motor spindle is not subject to pressure as in actual service. The apparatus shown in the illustration has been developed at the McKees Rocks shops of the Pittsburgh & Lake Erie for the purpose of testing motors under actual working conditions. As shown in the illustration the device is simple, consisting of an 8-inch air brake cylinder mounted in a vertical position between two heavy rods secured in a substantial base casting. The upper ends of the rods are turned down to 1½ inches in diameter to accommodate the special cylinder heads which serve to hold the cylinder in place. The lower sections of the vertical rods are retained at their original diameter of 2¼ inches.



Home-Made Air Motor Tester

For purposes of test, a motor is mounted in the device as shown, being guided at the drill by crossbar *E* and resting on test block *F*. Air is supplied to the cylinder through the flexible hose on the left and valve *A*. Valves *B* and *C* are three-way cocks so arranged that when *B* is closed and *C* opened, for example, air is admitted on top of the cylinder and exhausted from the bottom. This forces the piston down on top of the air motor with a pressure indicated by the gage and which can be regulated to any desired amount. Air is supplied to the motor by means of hose *D*, and after the test is over the motor can be released by closing valve *C* and opening valve *B*. There is approximately 100 pounds' pressure on the shop line.

For testing, the air motor is set up as illustrated with a 2-inch drill in the socket, the drill point resting on test block *F*. Pressure is applied slowly until the air motor is pulling to capacity. The revolutions per minute can then be counted and the pressure noted. The pressure required to stall the motor can also be noted, and, provided the condition of the drill point as regards sharpness is kept constant, this pressure will be a measure of the efficiency of the air motor. If the motor does not come up to the requirements it can be overhauled and the difficulty corrected. This apparatus proves very valuable for a comparative test of different motors as a measure of their efficiency under actual working conditions.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the secretary of the committee, C. W. Obert, 29 West 39th street, New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of the society for approval, after which it is issued to the inquirer.

Below are given the interpretations of the committee in cases Nos. 408 to 410 inclusive, as formulated at the meeting of December 8, 1922, and approved by the council. In accordance with the committee's practice, the names of inquirers have been omitted.

CASE NO. 408. *Inquiry:* What thickness is required under Par. M-3 of the Code for Miniature Boilers for the plate forming heads which are not an integral part of the boiler? The thickness for heads which have riveted construction is not definitely specified in this paragraph.

Reply: It is the opinion of the Boiler Code Committee that the term "riveted shells" in the first sentence of this paragraph is intended to cover heads, in case they are not used as tube sheets.

CASE NO. 409. *Inquiry:* Is it permissible, under Par. M-11 of the Code for Miniature Boilers, to weld on to the shell a half-coupling for the reinforcement to give the necessary four full threads?

Reply: It is the opinion of the committee that the reinforcing may be accomplished only by a riveted pad or its equivalent, or by building up the thickness of the plate by

(*Continued on page 56*)

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CONTENTS

The article on modern boiler shop equipment appearing in this issue of the magazine presents to our readers a plan of shop layout and machinery that has given excellent results in efficient locomotive boiler construction and repair work. The machines mentioned and their arrangement are only intended to suggest possible improvements in modernizing existing shops when new equipment is required and in aiding the design of a new maintenance plant of moderate size.

This introduction of the subject of machine and small tool requirements in the boiler shop offers our readers an excellent opportunity to express their ideas on what a well equipped shop should include in its equipment and the best method of promoting operating efficiency by properly locating the machines with relation to each other. We will be glad to receive comments on this subject and such letters will be published at regular rates.

The decrease in locomotive accidents during the fiscal year covered by the recent report of the chief inspector of the Bureau of Locomotive Inspection is a notable one. The improvement was most marked in the case of boiler explosions, which were reduced in number and in violence. The thirty-three boiler explosions occurring did, however, cause the death of twenty-two persons and the serious injury of fifty-six others.

Proper and adequate inspection followed by the careful observance of instructions in the repair of defects will still further reduce the number of accidents. To properly carry out the inspection work involved in the supervision of the motive power of the entire country, more inspectors are required and the chief inspector's recommendation that a sufficient appropriation be made to assure a competent and efficient staff should receive support by the Interstate Commerce Commission.

The additional recommendations embodied in the report on mechanically operated fire doors, power reversing gears, power grate shakers, water level indicating devices and the like should receive the careful attention of every individual connected with the equipment and maintenance of locomotives.

In attempting to reduce the hazard of oil country boilers, the Boiler Code Committee of the American Society of Mechanical Engineers proposed at the annual meeting of the Society in December that the diameter of the steam dome on such boilers be restricted to one-half the diameter of the boiler shell. Before this time no limit was placed on the size of the dome and, as a consequence, in designing for maximum steam space without increasing the cost, domes were built having diameters almost as great as the boiler itself. The openings in the shell were, consequently, so great in these instances that the strength of the entire unit was reduced below the point of safety. Undoubtedly many of the serious field accidents might be traced to this inherent weakness.

Even with the opening in the shell much smaller than the dome diameter, the strength is not materially increased since the line of rivets holding the dome to the shell marks a point of weakness which increases with the size of the dome. The reinforcing effect of the dome flange, although strengthening the boiler to a slight extent, cannot be depended upon to make up for the weakness in the shell.

At a public hearing in January, held by the Boiler Code Committee to give the manufacturers of boilers for use in the oil fields an opportunity of discussing the proposed restrictions, the concensus of opinion seemed to be that the proportion of five-tenths imposed too great a burden in the construction of these boilers and that the limit of dome diameter should be increased to six-tenths that of the shell.

The matter is still open for discussion but will be definitely settled within a short time by the Boiler Code Committee. The opinion of the committee is that the six-tenths allowance is liberal enough and that any increases in the dome size above this point will greatly lessen the safety of the boiler. Greater steam space might be obtained by increases in dome height or other modifications in the design of these boilers.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Ninety-Degree Elbow—Heavy Plate Construction

Q.—Would you please have some of the readers who have had experience on elbows show how the holes are laid off so as to bring the ends 90 degrees apart? On this job there was an angle iron ring on each end. The elbow is to be used for an air blast so the circumferential seams have to run the same way as the air. Both end pieces are of the same diameter. In the method I used, I worked with the neutral diameter, but the sides never came around to 90 degrees. The elbow was short 9/16 inch. The holes came fair, but the ends were not square. We had to put a turn-buckle to bring the ends square, and then the holes were away out. The boss said "one more chance."—W.F.

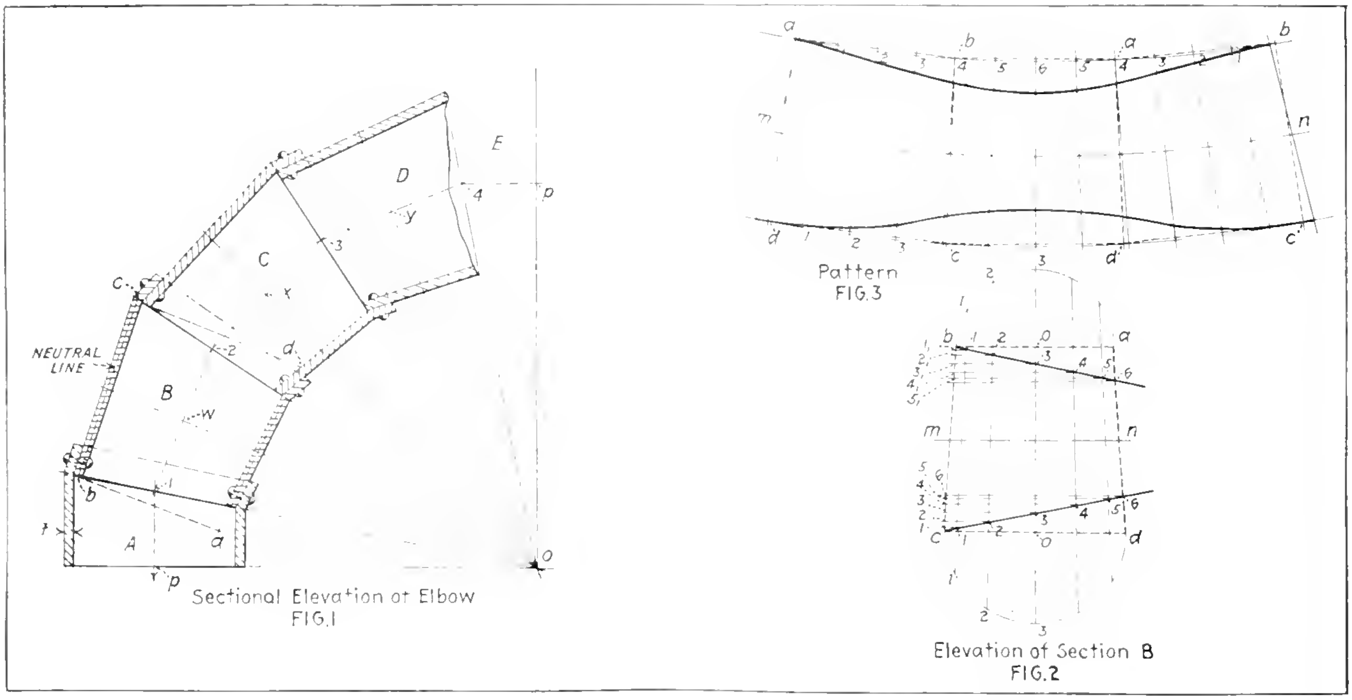
A.—The construction of one section of the elbow is given which will indicate the method of projection ordinarily applied in layouts of this kind. The plate thickness *t*, Fig. 1, is enlarged to show the tapered connections to better advantage. Lay off first the right angle *p-o-p* making the distance *o-p* equal to the depth of the elbow measured to the center of its openings. With *o* as a center draw the arc *p-p* and divide the arc into one less than the number of sections required in the elbow, thus locating the points *w-x-y*. Bisect the arc lengths *w-p* and *y-p* which locates the points 1 and 4. From point 1 set off the point 2 equal to *pw*, likewise locate the point 3. Connect *o-1*, *o-2* and *o-3* with straight lines on which lie the meters between the sections.

Consider the flow of air or gases to pass through the elbow in the direction shown by the arrow; in which case the elbow should be so installed that the gas travel is not affected by the overlapping plates at the joints. Fig. 1 shows the correct position of the joints to meet this requirement.

The next step in the construction is to draw the center line of each elbow section as *p-1*, which is at right angles to *o-p* and *1-2* which is at right angles to *o-w* and passes through point *w*. The axis *2-3* is perpendicular to *x-o* and passes through point *x* and *3-4* is perpendicular to *y-o*. The sections of the elbow are drawn in so that they taper in which case the difference between the respective ends is equal to 2 plate thickness as indicated in Fig. 1.

From Fig. 1 the pattern layout is obtained by first constructing a frustum of a cone of which the elbow section is a part, as shown at *a-b-c-d* of section *B*, Fig. 1. This section is reproduced in Fig. 2. In cases where the taper is slight a convenient and short method of laying off a pattern for frustum of a cone is shown in Fig. 3. The pattern of the frustum is essential in this development for obtaining the elbow pattern.

In Fig. 3 reproduce three sections of the frustum *a-b-c-d*,



Details of Layout and Construction of a Ninety Degree Elbow

Fig. 2, which is drawn to the neutral line of the plate thickness. Through the points *a-b-a-b* at the small end draw in the camber line and through *d-c-d-c* at the large end draw the camber for the large base. The line *m-n* in Fig. 2 bisects *o-o* and the corresponding position of *m-n* is drawn in Fig. 3. In Fig. 2 semi-circles are described from point *o* for the upper and lower base profiles of the frustum. They are then divided into equal parts and construction lines drawn in as shown. On the camber lines, Fig. 3, lay off the stretchout for the upper and lower bases by setting off the arc lengths *1-2, 2-3,* etc., of the semi-circles, Fig. 2. Then in Fig. 3 draw in the radial lines *1-1, 2-2* and *3-3,* etc. Where the miter lines, Fig. 2, intersect the radial lines at *1-2-3-4,* etc., locates the points for determining the true lengths of the lines *1-1, 2-2, 3-3,* etc., of the elbow section.

At right angles to the line *o-o* and from points *1-2-3-4* and *5* draw lines to intersect the outer element of the frustum as at 1_1, 2_1, 3_1, etc. The true lengths of the development lines for the elbow pattern are then transferred from Fig. 2 to Fig. 3, taking the respective lengths from the base line *m-n,* Fig. 2, and laying them off from *m-n* of Fig. 3. The lap for the riveted joint must be allowed and the holes spaced off equally. The rivet line on the opposite end of the pattern is spaced into the same number of parts but the pitch will be less on account of the end being smaller so as to fit into the larger end of the adjoining section. This completes the more essential steps in this layout.

Annealing Large Steel Castings

Q.—I am interested to know whether it has been the custom of your readers to anneal the stakes of hull riveters with the idea of preventing crystallization and breakage. Any information which you have on this point will be much appreciated.—C. W. F.

A.—Annealing of steel castings is an essential process used in producing a finer quality of cast material. Annealing affects the physical or structural form of the metal, reducing the coarser sections to a finer grain, thereby increasing its strength. In the formation of large castings such as the stake of a hydraulic riveter the annealing is done by allowing the metal to cool slowly in the mold, which is called *flask annealing.*

I am not aware of subsequent annealing being performed after the castings of such size are made. If it were done the process would require special equipment for handling the work. Special types of stakes are made, as for example a machine-turned solid forging of steel that is heat treated. Such machines are used for extreme riveting conditions requiring a long reach.

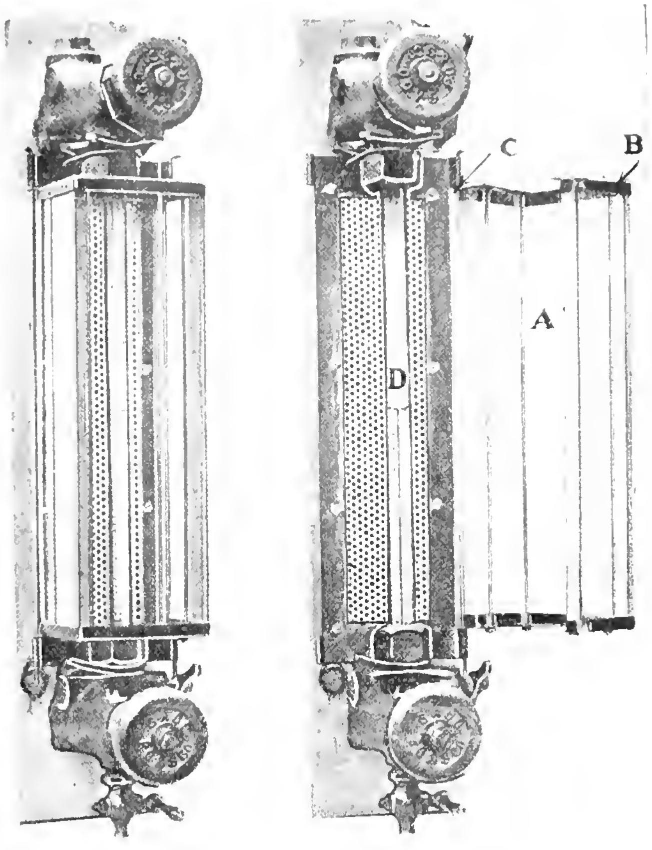
Guards for Water Gage Glass

Q.—I would like to have some information on the following subject: Our Safety First Committee insists that the water gage glass on a boiler should be covered with 1/4-inch mesh screen to keep the glass from flying into the attendants' eyes should it burst while under pressure. I do not have the late code. Do they make any reference to this? In my opinion this part of the boiler should be kept uncovered.—W. N. S.

A.—The A. S. M. E. boiler code contains no requirements for a protective water gage device of the type you describe or for any other type of this kind, except the automatic shut off valves on water gages.

The glass gage guard shown in the accompanying illustration meets the requirements of the department of safety appliances, Department of Labor and Industry, State of Pennsylvania.

This device is intended to protect the eyes of boiler room attendants against bursting gage glasses. The guard is made of a special grade of glass *a* which is held in position by a brass frame *b* and hinged at the back with bolts *c.* The hinge construction permits the protector to be opened to the right or left for installing a new gage glass. Observation of



Closed and Open Positions of Water Gage Glass Guard

the water level is readily made through the glass protector. This device is made by Reiber-Gibbs Company, Pittsburgh, Pa.

Calculating Strength of Plain Vertical Fireboxes

Q.—Why are the furnace sheets of vertical tubular boilers in which the furnace sheet is under 38 inches in diameter arranged with staybolting, the stays being pitched so as to place a greater load on same than is allowable in the A. S. M. E. Code rules, and the thickness of the plate such that requires no bracing for the pressure carried on the boiler?

Following is an example, the data taken from a boiler of this kind, which will more clearly explain my inquiry:

Furnace length, 27 inches; thickness of plate, 3/8 inch; diameter of staybolt at top of threads, 7/8 inch; diameter of furnace, 32 inches; pressure carried, 100 pounds; pitch of staybolts, 7½ inches by 8 inches. A. S. M. E. Code rule to be used where the length exceeds 120 times the thickness of the plate.

$$P = \frac{4250 \times T^2}{L \times D}$$

in which: P = allowable working pressure.
D = outside diameter of furnace.
L = length of furnace in inches.
T = thickness of furnace walls in 16ths of an inch.

This problem worked out allows a working pressure of

$$\frac{4250 \times 36}{27 \times 32} = 177 \text{ pounds, nearly, without any staybolting.}$$

The load on the staybolt is $100 \times 7\frac{1}{2} \times 8 = 6{,}000$ pounds, and the allowable working load on a 7/8-inch staybolt calculated from the root of the threads is 3,142 pounds at 7,500 pounds stress per square inch.

Now the following is what I cannot understand: The above boiler was built to safely carry a pressure of 177 pounds on the furnace sheet without staybolting, yet the furnace is staybolted, thereby taking the load off of the furnace and placing it upon the staybolts, the load on the staybolts being considerably above that which is allowed.—W. S.

A.—Circular furnaces for small vertical boilers can be made of plate heavy enough to carry the working pressures usually allowed on such pressure vessels. The furnace, however, is generally made of light material and stayed to give a more rapid heat transmission than is obtainable with heavier plate. The pressure acting on the firebox tends to collapse it, and, according to the A. S. M. E. Boiler Code, "A plain cylindrical furnace exceeding 38 inches in diameter shall be stayed in accordance with the rules governing flat surfaces." For smaller diameters, as previously stated, where lighter materials are used and which would not carry the desired working pressure, the furnace is stayed as a flat surface.

In your example, the length of the furnace is 27 inches, which does not exceed 120 times the thickness of plate, because 27 ÷ .375 = 72; therefore the formula (a) of Par. 239 should be used instead of formula (b).

Formula (a) is as follows:

$$P = \frac{51.5}{D} [(18.75 \times T) - (1.03 \times L)],$$

where P = maximum allowable working pressure, pounds per square inch.
D = outside diameter of furnace, inches.
L = length of furnace, inches
T = thickness of furnace walls, in sixteenths of an inch.

Substituting the values given in the example:

$$P = \frac{51.5}{32} [(18.75 \times 6) - (1.03 \times 27)] = 136.35 \text{ pounds per square inch.}$$

With a plate thickness of 3/8-inch, the furnace of this size 32 inches in diameter and 27 inches long will carry safely a steam pressure a trifle over 136 pounds; therefore, it was unnecessary to stay the furnace, as you state.

If the furnace is stayed as a flat surface, the formula

$$P = C \times \frac{t^2}{p^2} \text{ should be used,}$$

in which: P = maximum allowable working pressure, pounds per square inch.
C = 112, for stays screwed through plates not over 7/16-inch thick with ends riveted over.
t = thickness of plate in sixteenths of an inch.
p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows which lines may be horizontal, vertical or inclined, inches.

Using the pitch of stays, which is given as 7½ by 8 inches, and substituting the pitch, 8 inches, which is the greatest, the allowable working pressure equals $112 \times \frac{36}{64} =$ 63 pounds per square inch. The maximum pitch allowed by the A. S. M. E. rules for a working pressure of 100 pounds per square inch when the plate thickness is 3/8-inch, is 6 3/8 inches in cases where the surface is stayed as a flat surface. Using this dimension to determine the pressure on the stay, we have 6.375 × 6.375 × 100 = 4,053 pounds. The required diameter of stay taken at the root of the thread to support this pressure is found as follows:

The allowable stress on an unwelded staybolt less than twenty diameters in length, screwed through the plates, with ends riveted over is 7,500 pounds per square inch.

The pressure on the stayed surface divided by the allowable stress on the staybolt gives the required cross sectional or net area of the stay as taken at the root of the thread Thus, 4,053 ÷ 7,500 = 0.544 square inch.

The corresponding diameter at the root of the thread equals

$$\sqrt{\frac{0.544}{0.7854}} = .832 \text{ inch.}$$

The depth of thread on stays having 12 threads per inch United States Standard is 0.108. The overall diameter of staybolt equals 0.832 + 0.108 = 0.94 inch, which is a trifle greater than 0.9375 or 15/16 inch.

In your example, the stays are too small and the pitch is too great. This may seem unreasonable on account of the fact that the shell will carry safely a greater pressure unsupported. In using the stays, the problem is changed since the load is transferred to the stays. Therefore, in staying cylindrical vessels the plate and stays must have a strength sufficient to carry safely the maximum allowable pressure.

Distortion of Water Tubes in Yarrow Boiler

Q. I have been a reader of your valuable magazine for several months, and find that it contains some very interesting information. I am a boiler maker in the Navy and on a repair ship. I have had twenty-five years' experience at the trade, five years of which have been in the Navy on repair ships, and I have been up against some very complicated jobs, but one job in particular has gotten my goat, as the saying is. This job is on a Yarrow boiler, in which I have renewed a nest of 30 tubes twice, and have had a lot of trouble with the brick work; also this nest of tubes is located 8 rows in from the fireside up in the right back corner. I have renewed them twice, and each time after a few hours' run, each one of these tubes bags and the brick work cracks and falls out, although I allow ¾-inch for expansion for the brick, and they are anchored with ½-inch bolts set in the brick. All this trouble occurs after the boiler has been steaming for a few hours. I have reported the cause as being due to unequal expansion in the drums, as this trouble is about 3 feet from the top drum, and the tubes bag about the same place, while 11 other tubes are straight and even. I have had several arguments with the engineer about this, and he says there is no such thing as unequal expansion in a Yarrow boiler. Of course I cannot tell him what I think, but I do know that somebody is wrong.—E. L. A.

A.—In all types of boilers, whether firetube or watertube, the boiler materials are subjected to stresses arising from expansion and contraction of the metals. This condition is due to the temperature changes, as for illustration, the tubes and plates directly in contact with the intense heat from the fire will expand more than those further from it. Subsequent cooling of the metal causes contraction and the continued expansion and contraction, or breathing action, results in the plate cracking near riveted seams, and between tube ligaments, also in leaky tubes, rivets, stays and distorted tubes. From observation of the operation of boilers under great stress, it has been found that steel corrodes more rapidly than steel under less stress.

The tubes in Yarrow boilers nearest the fire being subject to the greatest heat and as they are longer than those in the interior of the tube nest, they have a greater expansion and consequently are subjected to a greater compressive stress.

To illustrate further the extent of tube expansion, consider that the temperature of the tube material in the fire is 300 degrees F., tube length equals 10 feet, or 120 inches, and coefficient of expansion equals .0000065, then the total increased length of the tubing due to expansion of the metal, equals 300 × 120 × .0000065 = .234 inch. As the upper tube drum also expands, additional compressive stress occurs on the tubes. The tube expansion is the same for all tube sizes and thicknesses, but varies with tube length and temperature. From the foregoing, it is evident that if the tubes are rigidly fixed with no provision for expansion, heavy bending stress occurs.

Since the steam and water drums do not permit the tubes to expand freely, the practice employed in some designs of water tube boilers is to bend the tubes slightly near the junction of the drums and tubes.

With boilers that have been in service for some time, sudden distortion indicates scale.

Tank Bottom Layout Correction

On page 561 of the December issue of the height on plate No. 6 of Fig. 2 should have been 4 feet 4¾ inches instead of the dimension 3 feet 9¼ inches indicated. This value is obtained from the solution of the triangle $\sqrt{30^2 - 6^2} = 29$ feet 4¾ inches. The distance C is 25 feet so the height x = 29 feet 4¾ inches — 25 feet = 4 feet 4¾ inches.

Smoke Abatement Work Progressing

The smoke abatement work at Grafton, W. Va., conducted by Osborn Monnett and L. R. Hughes, under the supervision of O. P. Hood, chief mechanical engineer of the United States Bureau of Mines, has been brought to a close. Excellent results were obtained, due largely to the hearty cooperation of the Baltimore & Ohio Railroad officials.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

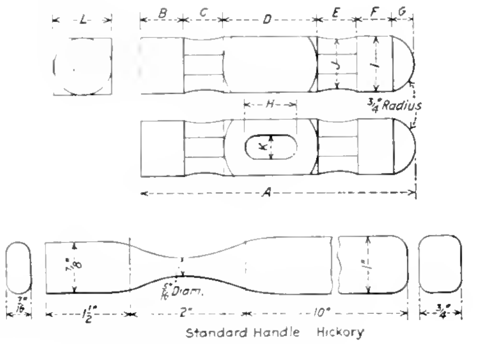
The Proper Type of Hammer for Testing Staybolts

This subject, which was brought up several months ago, is an interesting one to all boiler makers and inspectors. Of course there are several kinds and varieties of hammers used for testing staybolts, but the hammers in the accompanying sketch were used and adopted as standard by one of the largest railroad concerns in the United States.

We use two different hammers, the 1 pound and the 1½ pound. The 1½ pound hammer is used to detect broken or cracked flexible staybolts or bolts in the crown sheet. The

DIMENSION SIZE

	1 Lb Hammer	1½ Lb Hammer
A	4⅜"	4 7/16"
B	¾"	15/16"
C	11/16"	11/16"
D	1⅝"	1 9/16"
E	11/16"	11/16"
F	⅝"	9/16"
G	⅜"	⅜"
H	⅞"	⅞"
I	15/16"	1¼"
J	⅞"	15/16"
K	7/16"	⅜"
L	1"	1¼"



Details of Staybolt Testing Hammer

1 pound hammer is used to detect cracked or broken bolts of the solid type located in the door and side sheets. We also use a handle in the hammer as shown by the sketch with a very thin cross section located about 3 inches from the hammer. These hammers give very satisfactory results, but we use different methods in order to get the defective bolts in different types of engines.

As a matter of fact, the hammer is not the only main requirement in order to obtain good results, for a great deal depends upon the person doing the inspecting. One person has the ability and requirements to make a lawyer, but in any other capacity he would not do so well, and the same holds good in regard to boiler inspectors. If one is not adapted to the position, it is useless for him to try to become an expert as such.

In my opinion, in going over a boiler on a staybolt test, the inspector cannot get all the broken and cracked bolts. I have witnessed inspectors undergoing examination who were classed as good, but the results they obtained varied, some locating only one defective bolt while others located as high as 12 to 14. Some bolts which they marked as broken or cracked were of the flexible type and were merely unseated.

In our larger type of boilers, we apply a 100-pound cold water test as soon as it enters the shop for repairs. In this manner we are able to get very good results in locating defective bolts, especially in the crown sheet.

Testing Flexible Bolts

To test flexible bolts, we remove all caps and strike the head of the bolt two or three good smart blows so as to finish the break if possible; then we take a round nose tool and strike the head first on one side then on the other, twisting it so that in case it is fractured it will break loose. I have seen several tell-tale holes leaking on hydrostatic tests, but have very seldom seen an inspector locate the same while testing the bolts from the firebox side of the boiler.

In striking a staybolt, if the hammer gives a quick rebound, the bolt is all right, but if it does not rebound and apparently sticks to the bolt it is cracked or broken. One must not depend altogether on the rebound, but upon the sense of hearing as well; a fractured bolt gives off a dead sound and is very often easily detected by one standing close to the inspector at the time.

The Federal government requires that staybolts tested with water in the boiler must have at least 50 pounds pressure, otherwise the water must be drained and the test made, in which case the vibration of the sheet will indicate any unsoundness; the latter test is preferable.

Olean, N. Y. C. W. Carter, Jr.

Extreme Examples of Bad Workmanship From An Inspector's Records

Some of the methods used in repair work are decidedly questionable and the inspector runs across some rather dangerous practices in his every-day experience. Fortunately the following extreme examples of bad workmanship which the writer has found in some of his trips are not common, but it is interesting to see to what extent individuals will go to hurry along a given job.

In one boiler where it was rendered difficult to get the flues out of the boiler through their own hole, especially in the case of flues in the outside or bottom rows, the man on the job cut them off and allowed them to drop out of the way into the bottom of the barrel.

Another instance where a staybolt had been drilled by mistake the drilled hole was filled with electric weld and a new head also was formed by the electric welding process.

Bulges in arch tubes have been known to be heated by the acetylene flame and the bulge driven back with the help of a flatter.

Cracks in the side sheet that were anywhere from ¼ inch to 2 inches in length were calked without any other work being done to them.

Electric welds were applied to firebox sheets and surfaces without properly cleaning the sheets or surfaces.

Patch seams were merely seared over by electric weld without going to the very inner surface and working out as is necessary to obtain a good job.

Possibly some such work as the following would explain many of the firebox failures reported from time to time:

Cracks across the seam of the rear flue sheet where the flue sheet intersects the crown sheet were V'd out and welded. These cracks were anywhere from 20 inches to 32 inches long and there were also radiating cracks from the flue holes to the crack that were not touched.

One method of making tubes fit sometimes when small flues and superheater flues are cut too short by about ⅜ inch to ½ inch. In such an event a hot bar of iron is placed in the flues and when the flues expand to the proper distance they are clinched over and held in place.

Broken and cracked radials and staybolts are not always taken out of the boiler but leaky telltale holes are plugged so they will not give evidence of defects. It is the inspector's practice to rap only about 4 rows wide along the intersection of the side and crown sheets.

It seems to be the practice in some shops to get the engines out and going no matter what the conditions or hazards may be. Generally in such cases the roundhouse foreman has no more idea about the characteristics of a steam boiler than a kindergarten scholar would have.

An engine comes into the shop with a pressure ranging from 100 to 150 pounds of steam and within three-quarters of an hour it has been blown down and extremely cold water allowed to be put into the boiler thereby producing severe strains and stresses upon the boiler.

I have never yet with my three months' experience in a shop of this type seen the radial or crown bolts or staybolts tested as required by the law or even seen the crown bolts tested at all.

Boilermakers who have any pride in their work will at once condemn the above mentioned practices, yet they are carried on daily. Now that the Interstate Commerce Commission has ordered an inspection and investigation of locomotives and cars, will they allow such practices as those outlined to continue or will the rules and regulations be lived up to and enforced rigidly? Not being any too familiar with the machinery end, I have paid very little attention to this work, but I do know that the same way of doing things is carried on. The argument for an adequate governmental inspection staff is a good one.

New York. Inspector.

Photographs of Fire Tube Boilers

Just a short time ago the writer was asked by a prominent technical publication to write an article on steam boilers.

I wrote the article and of course I wanted to illustrate it. I wanted to show the difference between watertube and firetube boilers by means of actual photographs, and so wrote a number of letters to manufacturers of both kinds of boilers asking for photographs.

The manufacturers of watertube boilers responded immediately, offering me a variety of pictures, some of which I asked for. But the manufacturers of firetube boilers, for some reason or other, didn't have any photographs. They offered to furnish cuts, or electrotypes of cuts already on hand, but cuts were out of the question because of the policy of the publication. I was unable to get a single photograph that I could use.

This, I believe, should be of interest to manufacturers of firetube boilers. Progress cannot be made without consistent advertising. To advertise the firetube boiler properly it must be shown time and again in our trade papers. The manufacturers of watertube boilers were willing to go to considerable expense to have their boilers shown. Why shouldn't the same apply to firetube boilers? There is nothing about a firetube boiler to be ashamed of. Why not advertise it a little more? N. G. Near.

Newark, N. J.

Stamping Ohio State Boilers

(*Continued from page* 38)

"Whereas, The National Board of Boiler and Pressure Vessel Inspectors, organized for the purpose of standardizing examinations of applicants for certificates of compentency as inspectors of steam boilers; for the issuing of commissions to such inspectors; and for the uniform stamping of steam boilers; has completed its work; therefore,

"Be it Resolved, That the Ohio Board of Boiler Rules hereby approves of and will accept written examinations conducted by any political subdivision of the United States which is a member of the National Board of Boiler and Pressure Vessel Inspectors."

Due to the fact that this resolution permits the installation of boilers that are constructed in accordance with the A.S.M.E. code and stamped with the facsimile of the National Board, this department requests that the data on boilers stamped with the National Board stamp be filled out on the Standard A.S.M.E. forms and that the old Ohio Standard forms only be used when boilers are built in accordance with the Ohio Code and specifically stamped "Ohio Standard."

Work of the A. S. M. E. Boiler Code Committee

(*Continued from page* 50)

welding, and that the welding of the half-coupling on the outside of the plate is not permissible under this requirement.

Case No. 410. *Inquiry:* Is it the intent of Par. M-16 of the Code for Miniature Boilers that non-ferrous metal shall be used for the valve seat and also that the lifting device shall be of non-ferrous metal, as are required by Pars. 282 and 283 of the Power Boiler Section of the Code?

Reply: Attention is called to the fact that where the Rules of the Code for Miniature Boilers do not apply, those as above referred to in the Power Boiler Section of the Code are applicable.

BUSINESS NOTES

The Standard Conveyor Company, North St. Paul, Minnesota, has acquired the rights, titles and patents of the "Brown Portable" line of portable machinery for the handling of packed and loose materials. The plant of the Brown Portable Conveyor Machinery Company at North Chicago will be continued in operation until further notice.

Royal E. Terhune has been placed in charge of the Northern New Jersey sales territory of the Uehling Instrument Company, Paterson, N. J. Mr. Terhune was formerly associated with the Uehling laboratories and is well qualified to cooperate with power plant operators on the subject of power plant economy.

The Mine and Smelter Supply Company with branches through the west has taken over the distribution of Wilson plastic arc welders and Wilson welding metals. This company maintains branch offices in Denver, Salt Lake City and El Paso.

E. S. Lammers has returned to the employ of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., and will be in charge of controller sales in the industrial department. Since 1919, when he left the employ of the Westinghouse Company, until the present he has been test engineer for the National Tube Company, Lorain, Ohio.

The Conveyors Corporation of America, Chicago, Ill., has acquired the manufacturing rights of the Green steam jet ash conveyor from the Green Engineering Company, East Chicago, Ind. All orders for replacement parts and extensions to the Green conveyor will be filled by the Conveyors Corporation of America.

The American Engineering Company, Philadelphia, Pa., manufacturers of Taylor stokers and other equipment, has taken over the Standard Crane and Hoist Company and the manufacturing rights to the mono-rail electric hoist formerly known as the Standard. H. S. Valentine, chief engineer of the Standard Crane and Hoist Company, is directing the sales and supervising the manufacture of the hoists for the American Engineering Company.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

Vice-Chairman—D. S. Jacobus, New York.

Secretary—C. W. Obert, 29 West 39th Street, New York.

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Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—W. E. Murray, Seattle, Wash.

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Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Frank, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Boiler Makers' Supply Men's Association

President—W. M. Wilson, Flannery Bolt Company, Pittsburgh, Pa. Vice-President—George R. Boyce, A. M. Castle Company, Chicago, Ill. Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

Master Boiler Makers' Association

President—Thomas Lewis, G. B. I., L. V. System, Sayre, Pa.

First Vice-President—E. W. Young, G. B. I., C. M. & St. P. R. R., 81 Caledonia Place, Dubuque, Iowa.

Second Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry St., Bloomington, Ill.

Third Vice-President—Thomas F. Powers, System G. F. Boiler Dept., C. & N. W. R. R., 1129 Clarence Ave., Oak Park, Ill.

Fourth Vice-President—John F. Raps, G. B. I., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.

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Secretary—Harry D. Vought, 26 Cortlandt St., New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Ave., Columbus, Ohio.

Executive Board—L. M. Stewart, G. B. I., Atlantic Coast Lines, Waycross, Ga., Chairman.

TRADE PUBLICATIONS

Air Filters.—A new edition of the Midwest Steel and Supply Company (New York) catalogue, covering the apparatus made by this company for handling dirt and dust problems, and air filtration for industrial plants, will be distributed within a short time.

Boiler Capacity.—A folder outlining three features of Heine boilers—economy, flexibility and capacity—has been distributed by the Heine Boiler Company, St. Louis, Mo. An installation of oil-fired Heine boilers, in which these features accomplish excellent results in cutting down cost, is given as a notable example.

Industrial Lighting.—A new series of six bulletins on systems of lighting for various industrial uses has been issued by the Edison Lamp Works of the General Electric Company, Harrison, N. J. These bulletins cover the lighting of textile mills, pulp mills, woodworking plants, street lighting and the like. Former issues of lighting bulletins have been revised and brought up to date and may be obtained upon request.

Conical Mills.—Conical ball and pebble mills and their application to the field of grinding and pulverizing are described in catalogue No. 13 issued by the Hardinge Company, New York. The various methods of grinding for metallurgical purposes, the manufacture of cement, and in the fuel field are taken up in detail with an illustrated description of the construction of Hardinge mills and their applications. Specifications and applications of these mills are included in the bulletin.

Seamless Boiler Tubes.—The manufacture, properties and uses of "Shelby" seamless hot rolled boiler tubes are detailed in Bulletin No. 12 of the National Tube Company, Pittsburgh, Pa. One of the most important uses for seamless steel tubing is in boilers and until late years cold drawn tubes were found more satisfactory than those made by other processes. However, the process of hot rolling has been so far developed that tubes made by this process are becoming more generally used. Tables of properties of "Shelby" tubes and other useful data are contained in the Bulletin.

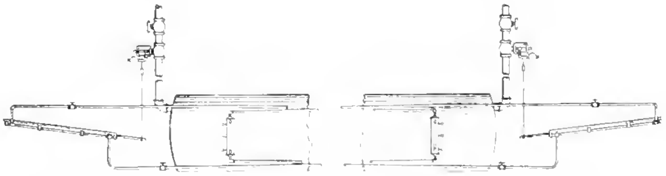
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,440,521. FEEDING WATER TO BOILERS. ROGER W. ANDREWS, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO NORTHERN EQUIPMENT COMPANY, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

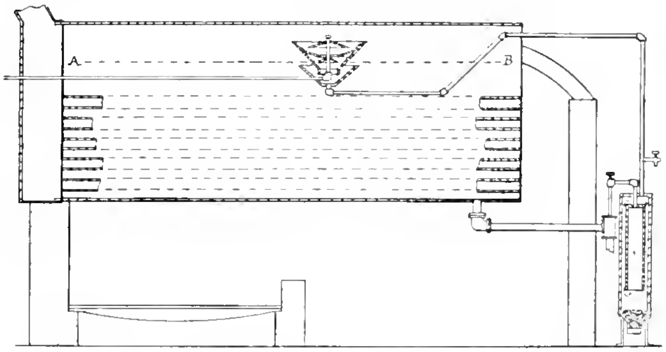
Claim 1.—A method of feeding water to boilers consisting in passing water into the boiler at two remote places, and in causing the relative



amounts of water passed therein to correspond to the relative levels of the water in the boiler adjacent the two places. Four claims.

1,440,103. METHOD AND MEANS FOR PURIFYING WATER FOR STEAM BOILERS. JAMES D. REEKIE, OF DULUTH, AND GEORGE M. CROSSEN, OF MINNEAPOLIS, MINNESOTA.

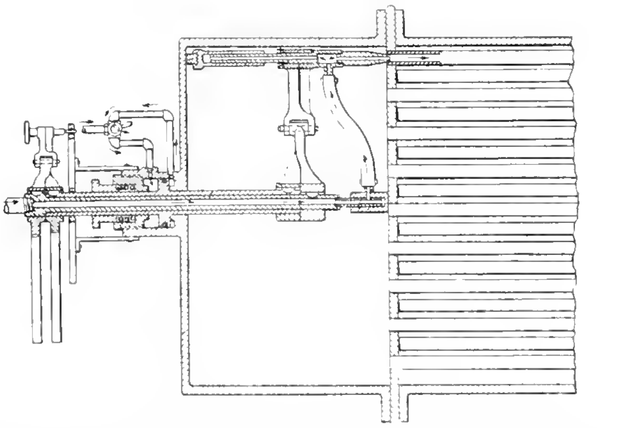
Claim 1.—The method of purifying water for steam boilers, consisting of causing the precipitation of scale-forming minerals in the feed water by beating the feed water within the boiler before said feed water has mixed with the



main body of boiler water, trapping the oil from said feed water within the boiler before either said oil or said feed water have mixed with the main body of boiler water, drawing said feed water and mineral precipitates out of said boiler free from said oil, trapping said mineral precipitates outside of said boiler, returning the feed water approximately free of said precipitates to the main or free body of water within the boiler, and occasionally blowing said trapped oil out of said boiler. Three claims.

1,441,431. TUBE CLEANER. JOHN F. KIRGAN, OF PHILLIPSBURG, NEW JERSEY, ASSIGNOR TO INGERSOLL-RAND COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

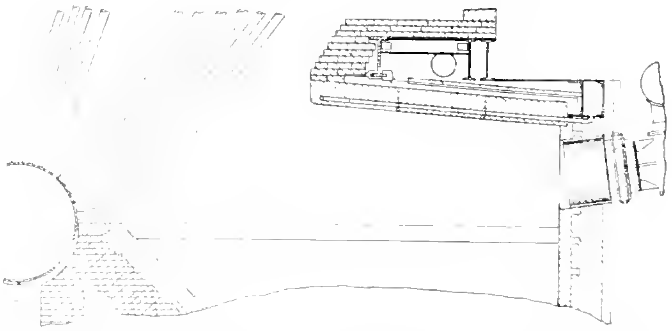
Claim 1.—In combination with a casing having a plurality of tubes and a chamber surrounding the ends of said tubes, a cleaning device adjustably



mounted in said chamber and selective means including separate indicia corresponding to individual tubes for effecting alignment of said cleaning device with individual tubes to be cleaned. Nineteen claims.

1,442,105. ARCH FOR THE FIREBOXES OF BOILERS. WILLIAM J. STOOP, OF WHEELING, WEST VIRGINIA.

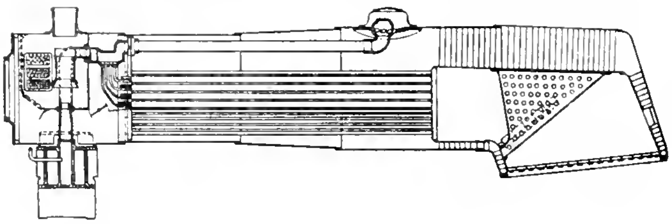
Claim 1.—An arch for the fireboxes of boilers, comprising a plurality of relatively-spaced parallel supporting bars arranged in approximately horizontal position over the firebox, an arch facing consisting of a plurality of courses of alined blocks, each course occupying the space between adjacent



bars and having the blocks thereof receiving support from the latter, the blocks of each course having therein passages which communicate to form a continuous ingoing and return duct for air whereby said blocks are cooled, an air-supply conduit located adjacent to the outer ends of said courses and having communication with the inlet end of the ingoing branch of each cooling duct, said cooling ducts having their discharge ends opening above said courses adjacent to the rear ends of the latter, and passages for conducting air discharged from said ducts away from the arch. Seven claims.

1,435,496. FEED-WATER SUPERHEATER FOR LOCOMOTIVES. LELAND G. PLANT, OF CHICAGO, ILLINOIS.

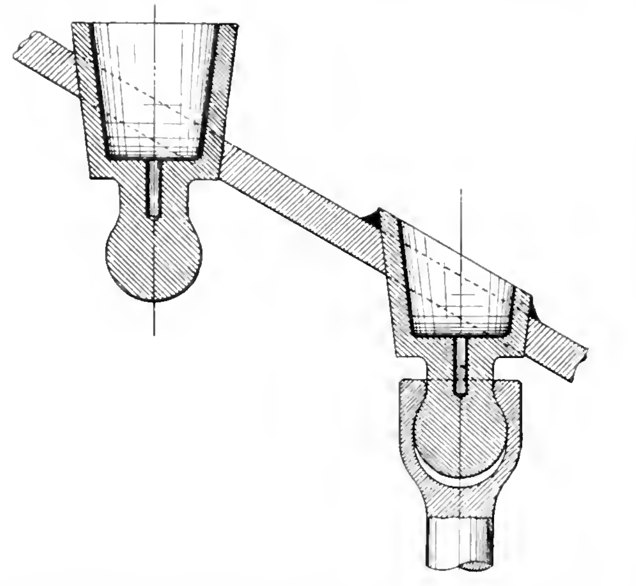
Claim 1.—A locomotive boiler and front end with the conventional arrangement of diaphragm, exhaust nozzle, cinder screen and stack for the continuous discharge of hot gases, vapors and cinders, in combination with a feed-water superheater, through which the boiler is fed; said superheater being composed



of many closely spaced water-tubes exposed within, and together occupying substantially all of, the conventional space between said screen and the blast from said nozzle; said screen converting the front-end cinders into a blast of scouring particles that pass between the closely spaced tubes and keep them clean; primary water-feeding-and-heating means positioned upon the exterior of the boiler and supplying the superheater with feed-water at temperatures that suppress the condensation of front-end-vapors thereon; and, means enabling the removal of solids from the interior of the superheater. Eighty nine claims.

1,435,733. SHEET CONNECTION FOR STEAM-BOILER STAYBOLTS. ARTHUR F. PITKIN, OF SCHENECTADY, NEW YORK.

Claim 1.—In a steam boiler staybolt structure, the combination, with a steam boiler sheet, of an end connection member, for articulation to a stay-



bolt, said member having a tubular body, the top of which is parallel with the boiler sheet, in which it is adapted to be secured, and which is inclined relatively to its axial line. Four claims.

THE BOILER MAKER

MARCH, 1923

Condensed Rules for Inspecting Locomotive Boilers*

By W. R. Hedeman†

Many of our readers are inspectors and are, therefore, well informed on exactly what is required of a locomotive boiler to make it a serviceable machine. However, the condensed outline of inspection procedure given below may be of general interest to them. For those who wish to become inspectors and for the men in the shop the information should be of very practical value for it indicates the points on which the inspectors will be most strict in their examinations and also the method of making repairs.

FOR convenience in carrying out locomotive inspections and for reference purposes the following outline of the work of a boiler inspector is given:

The most important features of each of the rules governing locomotive boiler requirements are condensed so that it is possible for an inspector at a glance to determine the correct procedure to be followed in all classes of inspection.

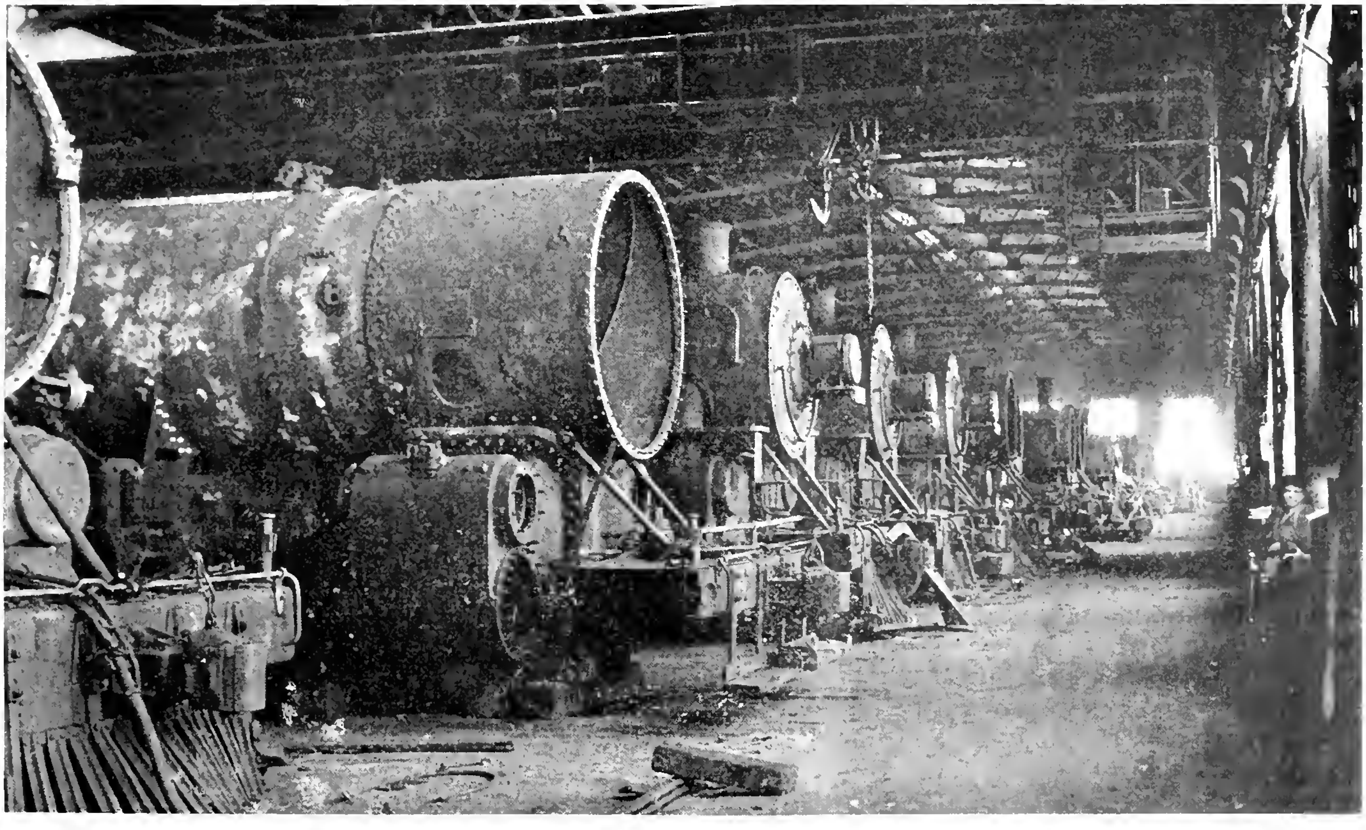
The responsibility for the basic design and maintenance of the boiler lies of course with the railroad over which the locomotive operates. For this reason the proper officials must be kept informed of the results of all inspections and closely checked up on the fulfilment of the suggestions made for the improvement of the safety of their motive power. The chief mechanical engineer or a competent engineer holding an equivalent position in the organization of the road generally determines the safe working pressure for a given locomotive and any change incorporated after the engine has been in service should come from his office in accordance with the requirements of the government inspectors.

On all locomotives after the first of the year 1923 a factor of safety of 4 is allowed in the design and any calculations carried out in determining the strength or working pressure are to be based on this factor.

The stress allowed on braces built before January 1, 1915, is 11,250 pounds per square inch. While on boilers built after that date only 9,000 pounds per square inch is permitted. In the case of staybolts on locomotives built before

*This article was prepared from a summary of inspection rules and should only be considered as a guide to procedure. The official law and rules should be consulted for specific details of inspection requirements.

†Chief Draftsman, Baltimore and Ohio Railroad at Baltimore, Md.



View of Boilers Under Process of Stripping in Erecting Shop

1915 the same stress allowance is permitted as in the case of braces, but on all constructed since that time 7,500 pounds per square inch has been made the maximum allowable stress. When new firebox and wrapper sheets are applied to boilers in the case of locomotives built before 1915 the stays and braces have to be changed in size and spacing or both to conform to the reduced stress requirement on locomotives of recent construction.

Inspection of Plates

At present, plates which do not show plant inspection and government test figures are limited to a tensile stress of 50,000 pounds per square inch which figure is to be used in design and repair calculations. Untested iron has an allowable stress of 45,000 pounds per square inch. Where plates have been tested, the figures stamped are to be used in calculations.

Iron rivets in single shear have an allowable stress of 38,000 pounds per square inch and in double shear 76,000 pounds. Steel rivets in single shear have a working stress of 44,000 and in double shear 88,000 pounds per square inch.

The responsibility for the maintenance of locomotives in good condition rests with the chief mechanical officer in charge at any point where inspections are made and it is his duty to see that the required inspections are made when due. These inspections of course are made by company inspectors who examine an engine in detail when it comes in from the road for repairs. The reports from roundhouse foremen and road service records, as well as the record of the last flue removal and the government inspection report are of use in determining the necessity for repairs. Not until the locomotive has reached the shop, however, is an opportunity given for a complete examination. Once it has been placed on the pit, while it is being stripped, the boiler is inspected for cracks and fractures and, if the flue reports indicate that they have not been removed within the maximum period allowed, their replacement must be included in the work performed. Not only at the time of complete general repairs should the boiler be examined for cracks, pitting, and the like, but whenever a sufficient number of flues are removed to allow a careful study of the condition of the boiler.

Flue Removals

The present rule for compulsory flue removal is after 48 months' service, provided the time was covered in five consecutive years. Actually many roads, especially where the water supply is bad, are obliged to remove flues after comparatively few months of service.

Whenever cracks occur in the barrel of a boiler such defects must be corrected immediately. Lap joint seams should be carefully inspected at frequent intervals for possible cracks or grooving.

Fusible plugs, if used, are to be removed and cleaned every 30 days and reported on the proper inspection form.

The exterior of the boiler is of course inspected before put in service and also whenever the jacket and lagging are removed. If it has not been necessary to remove the lagging for any other purpose within a period of five years it is then required with one exception—boilers in service before April 7, 1919, have a two-year extension allowance which makes the period seven years. After this, they go back to the five-year period. All boilers built after the above date are governed by the five-year rule. In addition, the lagging must be removed whenever it is considered necessary by railroad or government inspectors.

Testing Boilers Under Pressure

In considering the tests required, the original service test of 25 percent above working pressure is the first in importance. After this, the boiler must be tested under a corresponding water pressure every 12 months. At the time of the hydrostatic test the interior should be inspected as thoroughly as possible by removing the dome cap. The standpipe should also be removed, if necessary, in order to enter the boiler. A competent authorized representative of the railroad company must personally witness the tests and examine the boiler while it is under hydrostatic pressure. When repairs are complete, further tests are necessary. The boiler should be fired up and steam raised to the working pressure. At this time the boiler and appurtenances must be examined carefully. Cocks, valves, seams, bolts, rivets, and the like, must be tight and any defects which develop repaired at once.

Staybolt Tests

Rigid staybolts should be inspected at least once each month and immediately after the hydrostatic test. In examining, tap each bolt with a suitable type hammer and determine the broken bolts from the sound or the vibration of the sheet. The proper testing of bolts is a matter of training and experience on the part of the inspector. It generally demands long practice in acquiring the skill necessary to test bolts with judgment. When the boiler is filled with water there must be at least 50 pounds pressure on. The staybolt test is preferred when the boiler is empty, no pressure being exerted.

In the case of flexible staybolts with caps, remove the caps at least once every two years and also when required by government or railroad inspectors and examine the bolts thoroughly. Firebox sheets must be examined at least once each month to determine if there is any bulged portion or other indication of broken staybolts. Hammer test these bolts at each hydrostatic test period as in the case of the rigid bolts. This must be done when the pressure at least equals the working pressure. This inspection has to be entered in the special form required for bolts.

Flexible staybolts without caps are inspected at the same time and under the same conditions as the rigid bolts with the boiler under a hydrostatic pressure equal to the working pressure. A notation is made of their condition on the standard staybolt form.

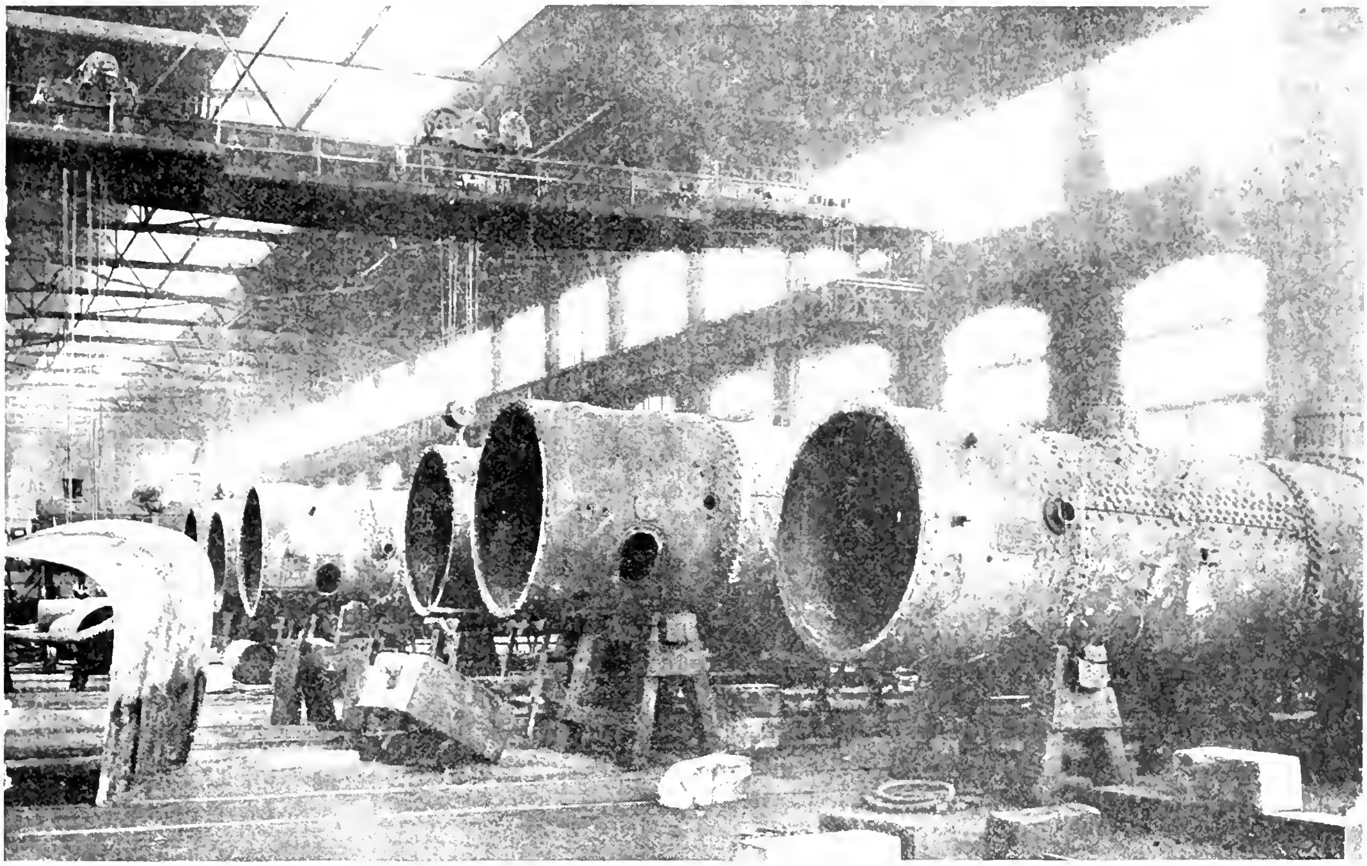
In connection with the staybolt requirements it must be remembered that a boiler is not allowed in service with two adjacent staybolts broken or with plug bolts. Three or more bolts broken or plugged in a circle 4 feet in diameter will make it necessary to take the engine out of service until they are replaced. Where five or more bolts are plugged or broken in the whole boiler the same ruling applies.

Telltale holes 3/16 inch in diameter and 1¼ inches deep must be drilled in the end of all rigid staybolts shorter than 8 inches in length. These holes must be kept open at all times.

At least one correct-reading steam gage should be installed on each boiler and so located that it will be kept cool and within easy reading distance of the engineer. With the gage, a siphon must be present of sufficient capacity to prevent steam from entering the gage. This pipe should enter the boiler direct and be kept tight. The siphon and pipe should be cleaned as well as all connections each time the steam gage is tested. The steam gage must be tested every three months or at any other time that an irregularity is reported.

At this point in the discussion of inspection it may be well to mention the location of the numbers used to identify the boiler pressure in reports and the like. The metal badge plate is found on the back head in the cab, the lagging and jacket being cut away so that the plate may be readily observed. The allowable steam pressure is stamped on this plate. On the front of the dome cap the builders' number or proper serial number assigned to the locomotive by the operating company is stamped.

At least two safety valves are to be installed on each boiler with sufficient capacity to prevent the building up of pressure in excess of 5 percent above the allowable working pressure.



Boilers Nearing Completion and Ready for Inspection Before Final Assembly

The Assembly Section of the Boiler Shop in a Modern Repair Plant

They must be set to pop at not over 6 pounds above the working pressure. In setting, two steam gages are used, one in full view of the person setting the valves. If these gages vary more than 3 pounds they should be removed, tested and corrected before attempting to set the valve. The gages should be tested immediately before setting the valves or changing the setting. The water level in the boiler should not be above the highest gage cock when the valves are set. The valves should be inspected under steam at least once every three months and, in addition, whenever any defects or inaccuracies are noted.

Water Glasses and Gage Cocks

The requirement for water level indicating devices is that there shall be at least one water glass on every boiler and that the lowest gage cock and lowest reading of the water glass shall not be less than 3 inches above the highest point of the crown sheet. Two valves or shut-off cocks are equipped with each water glass, one at the top and one at the bottom connection to the boiler. A drain cock must also be attached to the water glass and all located so they can be speedily opened or closed by hand.

The recommendations on water level indicating devices made to the Interstate Commerce Commission by the Chief Inspector of the Bureau of Locomotive Inspection in his latest annual report amplify the above requirement. All locomotives where there is a difference between the readings of the gage cocks and the water glass of two or more inches under any condition of service should be equipped with a suitable water column to which is attached three gage cocks and one water glass with not less than 6 inches, preferably 8 inches, clear reading and one water glass with no less than 6 inches, preferably 8 inches, clear reading on the left side of the back head of the boiler.

Water glasses should be so located and constructed that they will register the approximate general water level in the boiler under all conditions of service and show within one inch a corresponding level and must be so maintained that the engineer and fireman may have a clear view of the water in the glass under all conditions of service from their respective and proper positions in the cab.

The spindles of the cocks are to be removed at least once a month and the spindle and cock thoroughly cleaned of scale and sediment. The water glass should be blown out before each trip. To prevent accidents from flying glass in case of a disaster of any kind a suitable shield should be placed over all tubular water and lubricating glasses. A lamp should also be installed to reflect on the water level indicators so that the level may be under constant observation at all times.

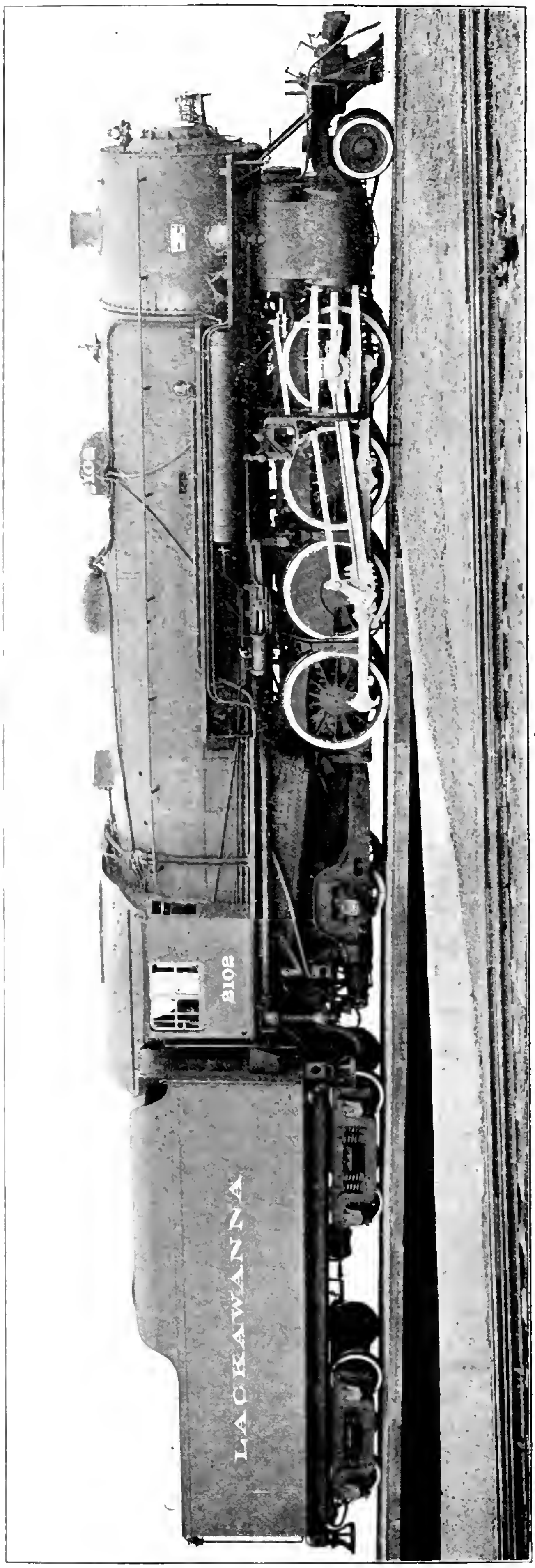
The injectors must be kept in good condition, free from scale and tested before each trip. The checks, delivery pipe, tank hose and valves should also be maintained in good condition and kept free from leaks and any foreign matter that would in any way obstruct the flow of water.

Flue plugs should be drilled with a center hole not less than 3/4 inch in diameter and tied together with rods not less than 5/8 inch diameter. In case of trouble with flues the plug should be removed and the flue repaired at the first convenient point.

Boilers should be washed out at least once every thirty days or oftener if the water conditions require it. All washout plugs, arch tube and water bar plugs are to be removed when the boiler is washed. The purpose of frequent washouts for arch and water bar tubes is to keep them free from scale and sediment and to permit free steaming. The records for washouts must be kept in order at all times.

It is important that all valves, cocks, joints, and the like, on the back head be kept tight so that no steam will be admitted in the cab to obscure the vision of the driver. If

(Continued on page 84)



The Delaware, Lackawanna & Western Mikado Type Locomotives are the Most Powerful Ever Built

Mikado Type Locomotives for the Lackawanna

General Construction and Boiler Details of the Most Powerful Mikado Locomotives Ever Built

With the addition of 40 new Mikado heavy type locomotives to the motive power of the D. L. & W. for helper and pusher service, as well as for regular road duty, the contemplated electrification of a 40-mile stretch of road near Scranton, Pa., has been indefinitely postponed.

Coal trains are made up and taken through solid from Scranton to the west or to the seaboard, the necessary additional helper and pusher service being given out of Scranton. The new Mikado locomotives with the helper service mentioned are now hauling trains of 2,900 tons through from Scranton to Secaucus yards, near Hoboken.

With these powerful locomotives a larger tender is used, the capacity having been increased from 10,000 gallons of water and 12 tons of coal to 12,000 gallons of water and 14 tons of coal. This increased capacity enables the locomotives under ordinary conditions to take a train to the summit east of Scranton without taking water and to run 130 miles from Scranton to Secaucus yard without taking coal.

The 40 new locomotives for the Delaware, Lackawanna & Western are noticeably heavier than those already in service and in terms of tractive force are the most powerful Mikado locomotives ever constructed. They were designed by the American Locomotive Company to meet the special traffic conditions on the D. L. & W. and were built at the Schenectady Works. These engines bear the road numbers of 2101 to 2140 inclusive. Their weight in working order is 356,500 pounds and their normal rated tractive force is 67,700 pounds. Being equipped with boosters having a rated tractive force of 11,500 pounds the total available tractive force for starting or heavy pulls is 79,200 pounds or 17 percent over that of the locomotive cylinders alone. The locomotive cylinders are 28 inches by 32 inches and the driving wheels are 63 inches in diameter.

The D. L. & W. has been a user of heavy Mikado locomotives in the past, having purchased 74 locomotives of the 1200 class which are essentially alike. The last order from this design was for 10 locomotives placed in 1920. These were also built by the American Locomotive Company. A comparison of the dimensions, weights, and proportions of the two designs will be found in the accompanying data table.

Boiler Details

The diameter of the boiler was increased from $84\frac{1}{4}$ inches to 90-5/16 inches, inside the first ring, while the length of the firebox was increased $12\frac{1}{8}$ inches without change in width, the grate area thereby being increased from 63.2 square feet to 70.4 square feet. The length over the tube sheets of 18 feet was retained but the number of 2-inch tubes was decreased from 303 to 300 and the number of 5-3.8 inch flues increased from 43 to 50. The total evaporative heating surface was increased 3.9 percent while the increase in superheating surface was 16.75 percent. In the new locomotives the superheating surface is 25.2 percent of the evaporative heating surface, a liberal allowance. Superheated steam is used not only for the main cylinders but also for the booster, the connection for the latter being made from the outside steam pipes. A combination exhaust stand is used for the locomotives and the booster cylinders.

A comparison between the calculated cylinder horsepower, and the calculated boiler horsepower shows they are practically the same and would indicate that these locomotives could be relied upon to be excellent steamers. The estimated coal rate when working at full capacity is 130 pounds per square foot of grate per hour. Stokers are provided, those for the new engines being furnished by The Elvin Mechanical Stoker Company.

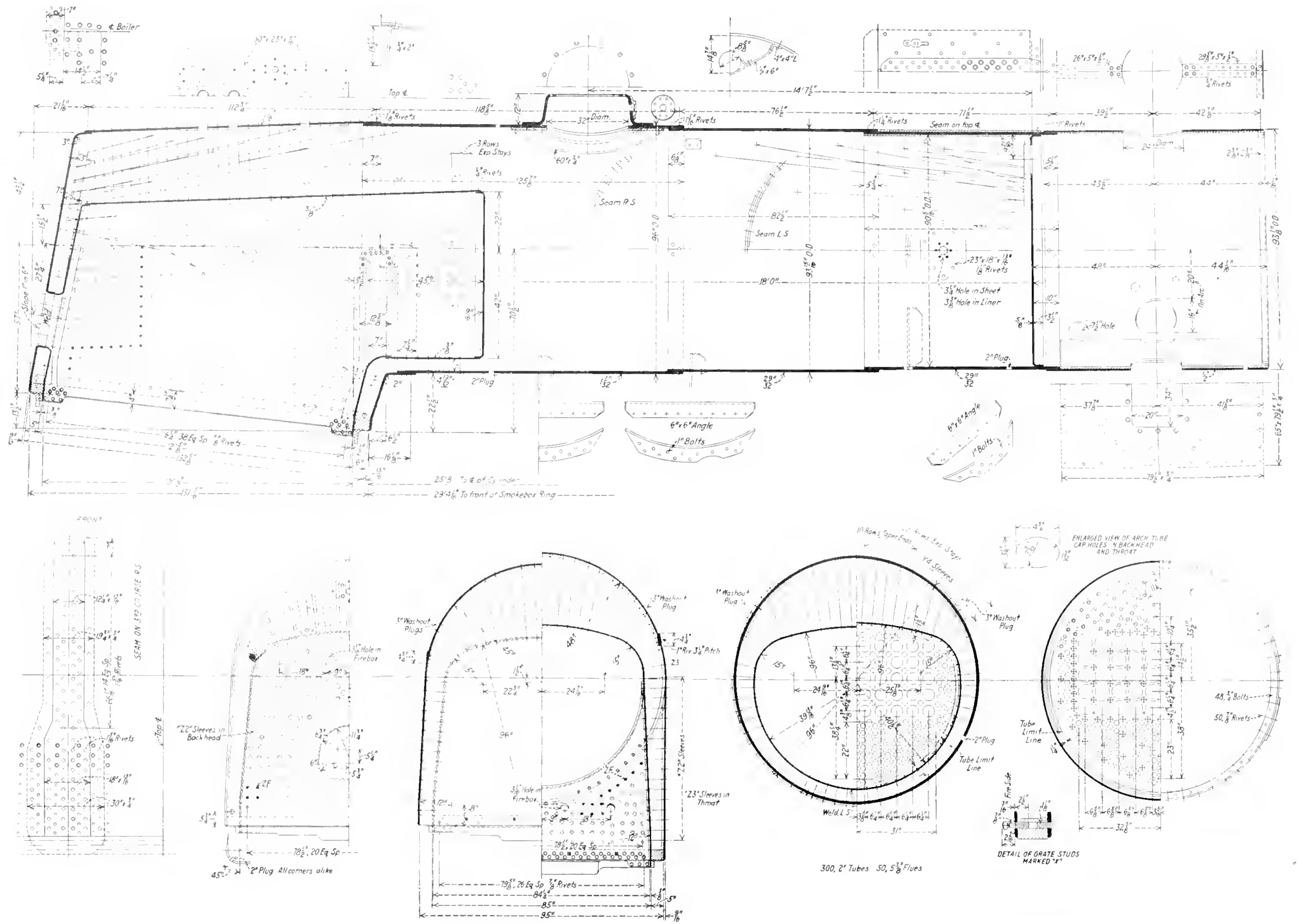
The height of the new D., L. & W. Mikado locomotive is 15 feet $4\frac{1}{8}$ inches, the extreme width 11 feet, and the coupled length of locomotive and tender 84 feet $5\frac{1}{2}$ inches. The smoke stack is 18 inches in diameter and the single exhaust nozzle 7 inches in diameter.

In addition to the booster, Elvin mechanical stoker and Baker valve gear other special equipment on these locomotives includes the Alco power reverse gear, power grate shaker, automatic fire door of the Butterfly type, Pyle electric headlight and Cleveland low water alarm.

These D., L. & W. Mikado locomotives will naturally be compared with those for the New York Central Lines, one of the most striking designs brought out in 1922 and for which orders were placed for 191 for the various roads comprising that system. The New York Central engines weigh 334,000 pounds, in working order, have 28-inch by 30-inch cylinders, and 63-inch driving wheels. They also are equipped with boosters and have a total rated tractive force of 74,500 pounds or 63,500 pounds without the booster. Other heavy Mikado type locomotives recently ordered are those for the Central of New Jersey weighing 342,500 pounds, having 27-inch by 32-inch cylinders and a rated tractive force of 59,000 pounds and those for the Northern Pacific weighing 337,000 pounds, having 28-inch by 30-inch cylinders, and a rated tractive force of 57,000 pounds. But few Mikado locomotives having a tractive force of over 60,000 pounds have been built.

Dimensions, Weights and Proportions D., L. & W. Mikado Locomotives

	2100 Class	1200 Class
Type of locomotive	2-8-2	2-8-2
Cylinders, diameter and stroke	28 in. by 32 in.	28 in. by 30 in.
Total engine weight	356,500 lb.	328,000 lb.
Tender weight	217,600 lb.	178,000 lb.
Wheel bases:		
Driving	17 ft. 0 in.	17 ft. 0 in.
Rigid	11 ft. 4 in.	11 ft. 4 in.
Total engine	37 ft. 4 in.	35 ft. 2 in.
Total engine and tender	73 ft. $2\frac{1}{2}$ in.	70 ft. $9\frac{1}{2}$ in.
Wheels, diameter outside tires:		
Driving	63 in.	63 in.
Front truck	33 in.	33 in.
Trailing truck	43 in.	43 in.
Boiler:		
Type	Straight top	Conical con.
Steam pressure	200 lb.	180 lb.
Fuel	Bit. coal	Bit. coal
Diameter, first ring, inside	$90\frac{5}{16}$ in.	$84\frac{1}{4}$ in.
Firebox, length and width	$120\frac{1}{8}$ in. by $84\frac{1}{4}$ in.	108 in. by $84\frac{1}{4}$ in.
Height mud ring to crown sheet, back	$72\frac{1}{2}$ in.	......
Height mud ring to crown sheet, front	$92\frac{1}{2}$ in.	......
Arch tubes, number and diameter	4—3 in.	4—3 in.
Combustion chamber, length	45 in.	$36\frac{3}{4}$ in.
Tubes, number and diameter	300—2 in.	303—2 in.
Flues, number and diameter	50—$5\frac{3}{8}$ in.	43—$5\frac{3}{8}$ in.
Length over tube sheets	18 ft. 0 in.	18 ft. 0 in.
Tube spacing	$\frac{13}{16}$ in.	$\frac{3}{4}$ in.
Gas area through tubes	730 sq. in.	737 sq. in.
Net gas area through flues	659 sq. in.	567 sq. in.
Total gas area through tubes and flues	1,389 sq. in.	1,304 sq. in.
Grate type	Rocking	Rocking
Grate area	70.4 sq. ft.	63.2 sq. ft.
Heating surfaces:		
Firebox and comb. chamber	315 sq. ft.	300 sq. ft.
Arch tubes	30 sq. ft.	28 sq. ft.
Tubes	2,813 sq. ft.	2,840 sq. ft.
Flues	1,260 sq. ft.	1,083 sq. ft.
Total evaporative	4,418 sq. ft.	4,251 sq. ft.
Superheating	1,112 sq. ft.	953 sq. ft.
Comb. evaporative and superheat'g	5,530 sq. ft.	5,204 sq. tt.
Special equipment:		
Brick arch	Yes	Yes
Superheater	Type A	Type A
Feedwater heater	No	No
Stoker	Elvin	Duplex
Booster	Yes	No



Structural Details of Boilers of Heavy Mikado Locomotives for the D. L. & W.

Tender:		
Style	Waterleg Acme	Waterleg
Water capacity	12,000 gal.	10,000 gal.
Fuel capacity	14 tons	12 tons
General data, estimated:		
Rated tractive force, 85 per cent.	67,700 lb.	57,100 lb.
Rated tractive force with booster.	79,200 lb.	......
Cylinder horsepower (Cole)	2,824	2,542
Boiler horsepower (Cole) (est.)	2,805	2,645
Speed at 1,000 ft. piston speed	35.2 m.p.h.	37.5 m.p.h
Steam required per hour	58,700 lb.	55,000 lb.
Boiler evaporative capacity per hr.	58,330 lb.	52,900 lb.
Coal required per hour, total	9,180 lb.	8,260 lb.
Coal rate per sq. ft. grate per hr.	130 lb.	131 lb.
Weight proportions:		
Weight on drivers ÷ total weight engine, per cent	76.1	78.0
Weight on drivers ÷ tractive force	4.01	4.48
Total weight engine ÷ cylinder hp.	126 lb.	129 lb.
Total weight engine ÷ boiler hp.	127 lb.	124 lb.
Total weight engine ÷ comb. heat. surface	64.5 lb.	63.0 lb.
Boiler proportions:		
Boiler hp. ÷ cylinder hp., per cent	99.3	104
Comb. heat. surface ÷ cylinder hp.	1.96	2.05
Tractive force ÷ comb. heat. surf.	12.23	10.97
Tractive force × dia. drivers ÷ comb. heat. surface	771	691
Cylinder hp. ÷ grate area	40.1	40.2
Firebox heat. surface ÷ grate area	4.9	5.2
Cylinder hp. ÷ gas area (tubes and flues)	2.03	1.95
Firebox heat. surface, per cent of evap. heat. surface	7.8	7.7
Superheat. surface, per cent of evap. heat. surface	25.2	22.4
Tube length ÷ inside diameter	122.7	122.7

American Machinery Market in Asia

EXPORTS to the Far East have increased sevenfold in five years, with every indication of continued rapid expansion. A most startling development in the foreign market for American industrial machinery is revealed in an exhaustive report on machinery markets in Asia by W. H. Rastall, chief of the Industrial Machinery Division of the Department of Commerce, just issued by the Bureau of Foreign and Domestic Commerce. Mr. Rastall for some years prior to and including 1911 was engaged in selling industrial machinery in Asia. In 1918-21 he revisited the Orient as trade commissioner of the Department of Commerce, on a special investigation of the machinery markets there, and found that the trade had developed tremendously in the decade between his visits. The unchanging East, says Mr. Rastall, is changing rapidly and profoundly. During the last three years Asia has absorbed as much machinery as it would have taken in five decades if measured by the standards of 1915. Within three years, these markets have absorbed some $178,000,000 worth of American industrial machinery.

The importance of export trade to the average American machinery manufacturer is increasing very rapidly. It was not many years ago that the domestic market absorbed easily almost all the domestic production, and the rapid development of the home territory provided a satisfactory increase in the domestic demand. This situation is changing, and year by year it is becoming more necessary to cultivate outside markets if business is to show a satisfactory expansion.

While an era of depression followed the boom years of 1918-20, indications are that the trade will largely readjust itself by 1924 and that the volume will never fall back to the level of pre-war days. Before leaving Asia Mr. Rastall asked several of the machinery dealers to estimate the level at which it would settle down, and they replied that it would not be less than 60 to 70 percent of the volume of 1920.

On the whole it appears that we can expect to export to Asia during the next few years an average of $40,000,000 to $50,000,000 worth of industrial machinery, and foreign sales managers will presumably be justified in developing their organizations to correspond to this basis.

The details of the Asiatic market, problems of selling, advertising, financing, shipping, packing, are discussed at length by Mr. Rastall, who has a wide practical experience as a salesman in these markets, as well as an expert knowledge of machinery.

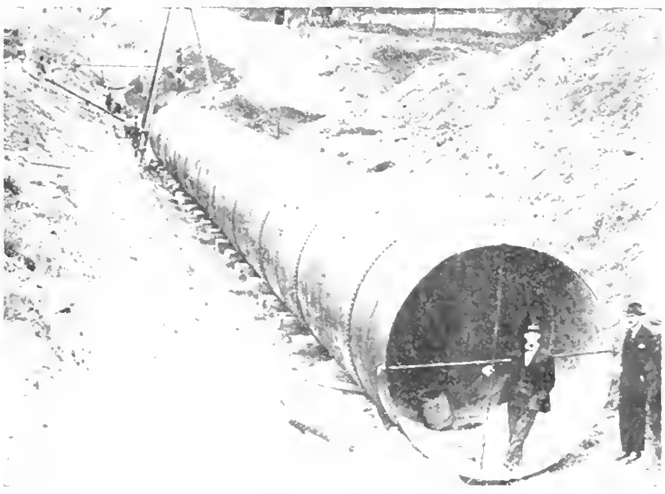
Mr. Rastall is now chief of the Industrial Machinery Division of the Department of Commerce, and is in a position to make his report of exceptional value to exporters by continued service. The Industrial Machinery Division is in constant communication through American trade commissioners, commercial attaches, and otherwise with the markets of Asia, so that its information is at all times right up to the minute, and any problems which are not conclusively covered in the present report can be handled through correspondence with Mr. Rastall.

The Department of Commerce report is available to all boiler manufacturers and others interested through any district or co-operative office of the Bureau of Foreign and Domestic Commerce or through the Superintendent of Documents, Government Printing Office, Washington, D. C.

Boiler Insurance and Inspection.—On page 16 of the January issue of The Boiler Maker an article on "The Inspection and Insurance of Steam Boilers" was published under the name of R. J. Furr. Credit for the source of a great deal of the data in this article is due S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Company, who presented a paper on this subject some time ago before the Insurance Institute of Hartford.

(Keystone View Co., N. Y.)

Unloading 11-Foot, 3-Inch Sections of 7-16-Inch Plate, Lap Jointed Steel Pipe at the Catskill Aqueduct, Fort Hill Steel Pipe Siphon



(Keystone View Co., N. Y.)

Sections of Pipe Assembled at the Catskill Aqueduct Which is Used to Supply Water for all Purposes to the People of New York

Boiler Manufacturers Hold Mid-Winter Meeting

American Boiler Manufacturers' Association Surveys Current Business Conditions and Broadens the Scope of Activities

THE regular winter meeting of the American Boiler Manufacturers' Association opened at 10 A. M. February 12 at the Hotel Astor, New York City, with about 35 members of the association in attendance. A. G. Pratt, president of the association, opened the meeting with a statement of the general status of the industry as he had found it since the June meeting. At the mid-winter meeting a year ago, held in Pittsburgh, signs were evident that the pendulum of business would swing back from the period of depression and good business follow. The last few months of the year have borne out this prediction and business at the present time in the boiler manufacturing industry is better than it has been at any time since early in 1920. Orders on hand indicate that this period will continue well into the summer at least. The present advances in prices of plate, bars, tubes and pig will necessarily increase costs. It is very essential that the members of the boiler manufacturing industry keep their businesses absolutely in order, utilizing the best available methods of organization and cost accounting in order to meet either continued good business or a falling off in business.

The coming months will probably bring an increase in the cost of material. Men for both skilled and unskilled positions in the boiler shop are scarce, this condition in certain sections causing somewhat of a hardship on the manufacturers.

General Conditions in the Industry

The officers of the association have been active in the routine and special work of the organization and the scope of the activities is gradually increasing. The majority of the members of the association should take a more active part in the conduct of its affairs, especially in the discussions held at the meetings. In order to obtain a general idea of the condition of the industry, the president suggested that the roll of the association be called, each senior representative present outlining the general conditions of business with his company, the size of the plant, the number of men employed, the status of production in relation to normal conditions, the outlook for new business and any special comment on conditions that might suggest themselves for discussion.

The response to this roll call indicated that the plants all over the country were working at from 50 to 85 percent of the normal production. Orders have been in good volume for the last few months of the year 1922 and, in most cases, the production for January of the present year was still better. Practically all of the companies have orders booked which will keep them active for five or six months. None of the members were willing to predict what conditions might be expected after that time.

Under this discussion of conditions, the question of training young men for responsible positions in the industry was suggested and this among other vital questions must at some time sooner or later be given careful consideration. In certain sections the question of the shortage of unskilled labor also requires settlement.

Most of the companies are buying material only as it is needed, very few having provided a surplus during the period of low prices. The cost of increases in material is reflected by increases in the cost of the finished product. Many companies have taken on the fabrication of special plate and tank work in addition to regular boiler construction and have found this phase of the industry an excellent means of maintaining their plants on a fairly normal basis. A few concerns have gone in extensively for the manufacture of portable type boilers and steam heating boilers with marked success.

Report of Secretary-Treasurer

Following this outline of business conditions, the secretary, H. N. Covell, gave a brief summary of the financial standing of the association and of the work of the membership committee. At present the treasury has a satisfactory balance and is on a firm foundation. A number of applications have been received for membership in the association, one of them coming from Canada and still others are in prospect. There are at present 73 active boiler manufacturing companies on the roll of the association, 22 associate member companies and one honorary member. The association should include in its membership every important boiler manufacturing concern in this country and the existing membership should make every effort to interest others in the work of the association and induce them to become members.

Work of the Uniform Boiler Law Society

E. R. Fish of the Heine Boiler Company, as a representative of the association on the A. S. M. E. Boiler Code Committee and on the Uniform Boiler Law Society, was called on to make a report of the activity of these organizations. He stated informally that the work of each was progressing rapidly; that at present the Boiler Code Committee was very active in revising the Code to take care of the rules governing the materials and construction of boilers in accordance with changes that have occurred since the Code was last revised. This revision will be completed within a month and will then be published by the Society. (These revisions have been appearing in THE BOILER MAKER as they are released by the A. S. M. E.) The question of rules for unfired pressure vessels has occupied the attention of the committee for some time, and several public hearings have been held on the proposed Code. The use of welding, which is extensive in this branch of the industry, has prevented an agreement on the rules by the various companies engaged in this work. However, within the last month or two a series of tests have been conducted on various types of welded tanks under the auspices of the United States Bureau of Standards in Washington. It is hoped that the results of these tests will indicate the degree of dependence which may be placed on welded tanks and, after the report of the tests has been considered by the interested organizations, a final draft of acceptable rules will be prepared by the Boiler Code Committee and finally adopted.

The Uniform Boiler Law Society has been active in promulgating the adoption of the Boiler Code in various states not having already accepted its provisions as standard. At present Charles E. Gorton, chairman of the administrative council of the Society, is working in conjunction with the legislatures of several states on various points which have come up in connection with the adoption of the Code by these states. In this work it has been found more advantageous for the states to pass enabling legislation calling for the appointment of commissions or inspection departments having the powers of adopting and enforcing the A.S.M.E. Code rather than to have the Code in a modified form placed on the statute books. In the latter case any changes from time to time that might be made in the Code itself to keep it abreast with developments and improvements in boiler construction could only be made by legislative action after a great deal of discussion and lapse of time. If the Code is enforced by a commission such changes may be adopted without the action of the legislature.

Mr. Fish outlined the points of difference between the work of the Boiler Code, the Uniform Boiler Law Society and the National Board of Boiler and Pressure Vessel Inspectors and the excellent work each is doing in its respective field. The Code deals with fundamental rules of construction only, the Uniform Boiler Law Society with the promulgation of the Code and the National Board of Inspectors with the uniform observance of the rules of construction and inspection by the states which have adopted the Code.

Massachusetts, which is the only state having in effect adopted the Code, but which still retains certain individual rules at variance with similar rules of the Code, is taking up the matter of revising the statutes to conform in every point with the Boiler Code. The meeting to discuss the matter is scheduled for March 21.

Method of Rating Boilers

W. C. Connelly, chairman of the Commercial Committee, gave a special report on the proposal of rating boilers on the basis of square feet of heating surface instead of the present horsepower basis In order to gain an idea of the sentiment of the members on this matter a questionnaire was submitted some time ago, asking for opinions. The results of the questionnaire are contained in a report which was read at the meeting. This report indicated the necessity of a standard basis for rating power as the variance was very marked in the methods used throughout the country. The term "horsepower" should be defined and the relation between it and square feet of heating surface standardized. There also should be a definite understanding of what constitutes heating surface in the boiler.

In brief, the report states that there were about 45 replies to the question of how to define the basis of boiler rating, horsepower or square feet of heating surface. Twenty-one firms answered that they rated their boilers by horsepower, eight by square feet of heating surface, 14 stated that they used both methods and one did not reply. In the case of watertube boiler manufacturers, practically all designated 10 square feet of heating surface as equivalent to one horsepower. The horizontal return tubular manufacturers designated from 10 to 12 square feet as equivalent to a horsepower. Manufacturers of the locomotive type boiler gave from 8 to 12 square feet, and the vertical type from 9 to 12 square feet and of the Scotch type from 7 to 12 square feet. With the exception of the builders of watertube boilers, no standard understanding of the term "horsepower" apparently exists.

On the question of specifying the boiler rating in proposals, most firms use both horsepower and the square feet of heating surface as a basis. The next few questions were designed to gain an idea of the sentiment of the members in standardizing the matter of rating either on one basis or the other. Most firms stated that they would be willing to adopt the standard practice established by the majority. The definition of what constitutes heating surface was brought up in the questionnaire, the question having arisen as to whether in calculating the heating surface only that portion of the boiler having water on one side and hot gases on the other should be included. Thirty-nine firms favored this understanding of the rule. The question of including integral economizers in computing the heating surface of the boiler or whether such economizers be mentioned as a separate item in the specifications brought forth the reply that in most cases the economizer is considered as a separate item.

In the discussion that followed the reading of this report it appears that opinions varied in determining the heating surface on whether the inside or outside diameter of the tubes be used in the calculations. It was suggested by G. W. Bach that the committee check the standards of the American Society of Mechanical Engineers and others who have considered this matter and present the facts at the next meeting.

It developed that the Power Test Code for boilers, which is now being compiled, will state what constitutes heating surface and on what basis boiler ratings will be made. The question of economizers will also be covered by the Power Test Code. It is believed that the word "horsepower" will be eliminated from the Code as this basis is illogical as applied to boilers since the co-relation between boiler and prime mover has disappeared.

Many clients of the horizontal return tubular boiler manufacturers understand the horsepower rating better as a basis for specifying boilers and the best method of procedure in these cases is to use the square feet of heating surface rating and also indicate the horsepower rating at the same time. It would be advisable to establish the relation of 10 square feet or some other figure agreeable to the majority as the relation between heating surface and horsepower.

The committee at this time did not feel called upon to make any definite recommendations as to rules establishing a basis for boiler ratings, but indicated that the discrepancy in practice required action looking towards standardization. The meeting voted that the committee be continued and, after investigating the matter further, make recommendations at the June meeting.

Related Industries Committee

No formal report was made by the Related Industries Committee. It was pointed out that at the last meeting of the joint committee with the Stoker Manufacturers' Association the question of power plant manufacturers, builders of pumps, economizers and the like being asked to co-operate with the boiler association was brought up. There are many subjects of common interest between these manufacturers and the builders of boilers and stokers and a great deal might be gained by their active co-operation. It would be of advantage to have the manufacturers of superheaters and economizers represented on the Related Industries Committee. Since the principal superheater companies are already associate members, it is possible for them to be placed on this committee and the manufacturers of economizers invited to become associate members of the association. This matter was referred to the executive committee for action.

Report of the Stoker Committee

A. G. Pratt, chairman of the stoker committee, asked for an expression of opinion on the value of the data sheets now being exchanged with the stoker companies. Practically every case where the reports were being made have proved extremely helpful in saving delays and alterations which often occurred before the association actively co-operated with the stoker manufacturers. The work of the drafting room is greatly facilitated by the use of the data sheets. A. G. Pratt suggested that the members present check up their staffs to determine whether these reports are being used as extensively as they might be.

Another matter discussed at the last meeting of the Stoker Manufacturers was the necessity of establishing the proper dimensions for the diameter and height of stacks. This subject was referred to the joint committee and the findings of this committee will be referred to the association at the June meeting.

Another subject which requires discussion is the proper relation between the grate area and the heating surface for hand-fired boilers.

The industry has in general adopted cost accounting systems of one form or another in accordance with suggestions made by the committee during the last two or three years.

In the absence of the chairman of the committee, S. H. Barnum told briefly of the budgeting system outlined by the Chamber of Commerce of the United States. A pamphlet describing budgeting was sent out to the members some time ago. The basis of suggestions made is that an organization should be laid out to accomplish a given amount of production and, if necessary, such an organization could be expanded to take care of peak production over short periods. This is infinitely better than for an organization to be developed for a peak production and then required to operate at a somewhat lower level.

Before the next meeting it is hoped that an idea may be given of what the members have done in the matter of budget systems.

Rules for Inspection

S. H. Barnum also presented a report of the committee representing the American Boiler Manufacturers' Association on a sub-committee of the A. S. M. E. Boiler Code. This committee informed Charles S. Blake, chairman of the sub-committee of the Boiler Code, of the action taken at the June meeting by the manufacturers' association with reference to rules for inspection and boiler tolerances. In the report to the Boiler Code sub-committee it was stated that, with the exception of four changes in the phrasing, the balance of the report was entirely satisfactory to the association.

Charles S. Blake, chairman of the Boiler Code sub-committee, replied to this report that the suggestions of the association would be acted upon. A further report on the subject will be made at a later meeting.

G. W. Bach read an extensive report of the action taken at the recent meeting of the Smoke Prevention Association at which standard setting heights for horizontal return tubular boilers were proposed. These standards were prepared after a study of conditions in the middle west and cannot be considered as acceptable standards for the entire country. The smoke department did not indicate a willingness to co-operate with the boiler manufacturers or with other bodies in establishing standards which would be acceptable to all those interested.

The report of the Boiler Manufacturers' Association on minimum setting heights presented at the June meeting is a much better standard for the association to follow where the jurisdiction of the Smoke Prevention Association does not extend. If it were possible to influence the Smoke Prevention Association to consider or adopt the standards proposed by the manufacturers, the basis would be better than their own since the heights were determined for a variety of different types of fuel in addition to the other considerations entering the problem. The matter was finally left with the committee to suggest that such action be taken by the Smoke Prevention Association.

W. A. Drake outlined in brief the status of the steam heating boiler construction among manufacturers. Few manufacturers keep data on the various installations made but an attempt will be carried out before the annual meeting to collect sufficient data on the subject to present information on both power and heating boilers in tabulated form. The members of the association will give the committee all the information available so that the report will be of the greatest value when finally compiled.

Standardization and Simplification

On October 2, 1922, the Department of Commerce of the United States requested that a committee of the American Boiler Manufacturers meet with representatives of the Department in Washington to discuss the possibilities of simplification and standardization in the boiler industry. Since the representatives of the Department of Commerce were not informed on boiler manufacturing problems to any great extent a memorandum was presented giving the general details of various type watertube and firetube boilers the members of the association manufacture. No statistics were available showing the total boilers manufactured or the number of firms building boilers. The export business was reported as small. Many difficulties prevent the general adoption of standards since most boilers are made to order and not on a production basis. It was pointed out to the Department of Commerce, however, that the association is aiming in every possible direction towards standardization of general construction rules and the inspection of boilers as evidenced by their co-operation with the American Society of Mechanical Engineers, Boiler Code Committee of the A. S. M. E., the National Code of Boiler and Pressure Vessel Inspectors and the Uniform Boiler Law Society with the Stoker Manufacturers' Association, the Smoke Prevention Association, and others.

This outline of the activities of the association was well received by the Department of Commerce, its representatives not realizing that the matter of simplification had been so thoroughly gone into by the boiler manufacturers. No criticisms or suggestions were offered and the Department volunteered its services in any manner which would aid the Association in furtherance of its work on standardization.

From time to time the association is being requested to send representatives to meet with other associations and it is found that the prestige of the association is very rapidly growing.

A report on the progress of the Standardization of Bolt Nut and Rivet Proportions Committee was read by F. G. Cox. So far this committee has not taken up the matter of rivets for boiler work but will probably at one of its early meetings reach this point in its considerations. It is felt that the best interests of the industry will be well taken care of when this division of the subject is discussed.

Following this, the sentiment of the association was established in regard to various matters of interest to the industry which are being considered by Congress, including the Hull bill, the immigration laws and others.

Reports on the progress of the National Board of Boiler and Pressure Vessel Inspectors were read. These papers are given below.

Manufacturers Adopt National Board Stamping Service

By Joseph F. Scott

AT the last annual convention of your association, a report of the activities of the National Board of Boiler and Pressure Vessel Inspectors was delivered to you and at this convention a schedule of graduated prices was adopted covering the filing of manufacturers' data reports, such prices being based upon the horsepower of boilers.

Since then we have communicated with the various boiler manufacturers who operate under the A. S. M. E. Code and the secretary reports that there has been a very noticeable increase in the number of boiler manufacturers who are now operating in cooperation with the secretary's office of the National Board of Boiler and Pressure Vessel Inspectors. The results have been very satisfactory from a financial standpoint, in fact revenues have increased to such an extent that operation and maintenance of the secretary's office is very nearly self supporting and no doubt it will be self supporting from now on owing to the attitude that the boiler inspection department of the state of Ohio has assumed since C. O. Myers has once more assumed the office of chief inspector. No doubt you have received a letter circulated by Mr. Myers sanctioned by H. C. Witter, Director of the Department of Industrial Service of Ohio (published on page 38, February issue of The Boiler Maker) and this letter explicitly sets forth the operation of the boiler regulations in relation to the provisions of the National Board of Boiler and Pressure Vessel Inspectors.

The loss of Ohio since the organization of the National Board has seriously affected the progress of the National Board but with the additional boilers that will be registered in the office of the secretary of the Board through Ohio not only will the additional money received be ample to take care of expense of the secretary's office but will enable us to hold a convention annually which is badly needed.

If there are any suggestions or recommendations to be made that will assist in improving the activities of the National Board and which are in harmony with the Boiler Code Committee of the A. S. M. E., such recommendations will be gladly received. I might suggest further that in the functioning of the National Board with the various manufacturers and others interested should any improved suggestions occur, the person offering such suggestions should forward same in writing to the secretary's office. With this method we will gradually arrive at a point of cooperation in our activities which will naturally tend to produce prompt results and overcome delays and misunderstandings.

Progress Report of the Board of Boiler and Pressure Vessel Inspectors

By C. O. Myers

THE National Board of Boiler and Pressure Vessel Inspectors actively launched its program to secure one stamp, a uniform enforcement of the code, and uniform approval of specific designs of boilers, about 18 months ago. Today all of these ambitions have not been realized, but wonderful progress has been made toward securing one stamp, and not a great deal has been done toward perfecting the others, as we are moving slowly, making sure of our ground before going further. With the stamping question once solved the rest will be easy, as the settling of this question interlocks the various states and keeps them into close contact with one another.

The problem of stamping is one of the principal objects, and one which needed our first attention. We have given practically all of our time to this question, and we are pleased to say that we have a system of registering and recording A. S. M. E. boilers that no state need fear a counterfeit code boiler, if it bears the National Board fac-simile. We have a system of registering and commissioning inspectors that makes it almost impossible for an incompetent person to inspect a code boiler and stamp it with the National Board stamp. Every precaution possible is imposed on the inspector, as we realize that upon him rests the responsibility of interpreting and applying the code as the code committee intended it.

We are in hopes that before another year goes by that our treasury will be in shape to take care of a meeting of members of the Board, at which time I am sure that this movement will be understood well enough that all the kinks can be straightened out.

At your mid-winter meeting four years ago I called your attention to what might happen in one of the code states without a system of regulation. Two years later a law was passed in the face of a protest from a committee of your association, which brought about a condition much worse than was anticipated, and the department has degraded to the extent that it is little better than a nuisance to all parties who must deal with them. Certain concessions were granted to your committee under a pressure that saved the department from going under altogether.

The practical demonstration of what has happened in a well organized state in less than 18 months should be warning enough for all of us to know, what to look for should this happen in several of the other code states. A well organized National Board will tend to stabilize conditions of this kind, and reduces the effect considerably.

With reference to the code states and municipalities that have officially adopted the National Board stamp, it is easier for me to give those who have not accepted, and they are Michigan and Missouri. The chief inspector of Michigan personally advised me that it is not necessary to stamp boilers Mich. Std., and that all that is required is the A. S. M. E. symbol. In the state of Missouri it is necessary to have the law amended, and steps are being taken to have this done.

At your annual meeting last June it was recommended that the registration fee be reduced. These fees were reduced beginning July, 1922, in accordance with your recommendations and it has proven that this was a wise move. Prior to the reduction of the fees there were registered altogether 503 boilers by 18 concerns; since then there were 2,664 boilers registered by 26 concerns.

We were operating at a loss until October, and since that time we have been just about holding our own, and with a little increase in registration fees over and above that received for the last three months the National Board will become a self supporting institution.

While it has been a rather long struggle we feel that the National Board at the present time is thoroughly established, to accomplish the work for which it was brought into being, especially if we are given the wholehearted support of those which the National Board benefits.

Repairs Under Pressure*

TWO fatal accidents that occurred recently were directly due to the highly dangerous practice of attempting to repair boilers, steam pipes, and other closed vessels and objects while they are under pressure. We have repeatedly warned against this practice and the hazard has often been pointed out in other ways; but the frequency with which accidents from this cause continue to occur is discouraging, and it is evident that this very real danger is often ignored, or at least receives too little consideration.

One of the accidents to which we refer occurred in connection with a watertube boiler. This boiler is one of a battery, and had been shut down for a time. In the process of putting the boiler in service again, steam had been raised to a pressure of 130 pounds, but the boiler had not been cut in on the line. A leak was discovered around one of the tube-caps in the front water leg, and the attendant tried to "roll in" the cap. The cap was of a somewhat unusual type, and during the operation it was pushed in, and a stream of boiling water under 130 pounds pressure rushed out directly into the attendant's face. The man was hurled against a coal pile about twelve feet distant, and almost instantly killed.

In the other case, two men were attempting to stop a leak at the flange of a reducing tee on a steam-pipe line. They had put a packing ring or gasket in place and were tightening the bolts which compress the gasket between the flanges. This caused the steam pipe to pull out of the tee, and the parts separated a distance of about eight inches. The escaping steam blew one of the men off from a timber on which he was standing and into a concrete wheel-pit. The other man was blown from a ladder, but was able to go to the boiler room and have the steam shut off. On returning to the scene of the accident it was found that the first man was fatally scalded. He was removed to a hospital but died within a short time. It is said that previous attempts had been made

* Material supplied by The Travelers' Standard.

(Continued on page 82)

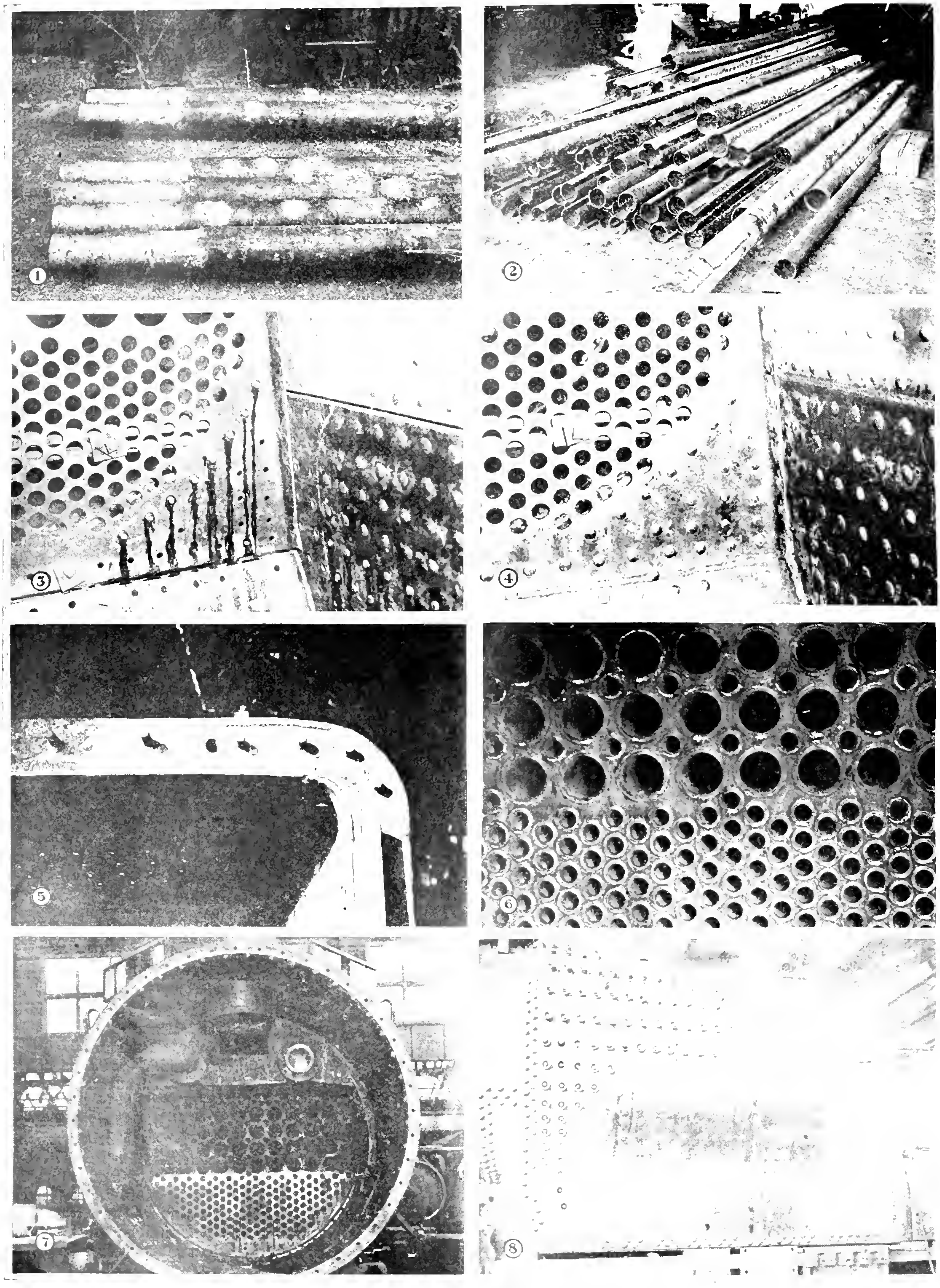


Fig. 1.—Reclaimed Tubes. Fig. 2.—Split Tubes to Be Made Into Sheets. Fig. 3.—Seams Ready for Welding. Fig. 4.—The Completed Weld. Fig. 5.—Welded Mud Ring Corner. Fig. 6.—Tubes Welded in Sheet. Fig. 7.—New Section in Front Tube Sheet. Fig. 8.—Welded Sleeve Flexible Staybolts.

Boiler Welding Practice on the Southern Pacific*

Electric Arc and Gas Welding Processes Used Extensively for General Boiler Repairs at the Sacramento Shops

ALTHOUGH much has been written concerning the application of electric arc and oxy-acetylene welding we have yet much to look forward to, as during the last few years an unusually rapid advance has been made in both of these methods of welding and they have now become recognized as an art very essential to many industries and particularly essential to the railway industry.

In the tube shop every day hundreds of various sizes and lengths of boiler tubes are repaired. Autogenous welding makes it possible to reclaim many tubes which otherwise, on account of the deep pitting, it would be necessary to scrap. These are reclaimed by filling in these pits by welding with either the oxy-acetylene or electric arc; this operation restores them to serviceable condition, making them practically as good as new tubes. A number of tubes reclaimed in this way are shown in Fig. 1. Many of the larger size tubes from 4 inch to 5½ inch diameter that are beyond repair due to excessive pitting are split the full length of tube with the oxy-acetylene torch and flattened out (Fig. 2). The plate thus obtained from the tube is used for various purposes. Practically all the larger tubes scrapped are thus reclaimed.

Boiler work develops an extensive field for both the oxy-acetylene and arc welding processes. When the inside firebox must be removed, instead of cutting it out as we were formerly forced to do with drills, hammers and chisels, the oxy-acetylene process is now employed. The work is performed not only quicker and cheaper but with less hard labor and with more satisfactory results. In fabricating the new firebox to replace the old one removed we find in laying out the sheets that form it, that numerous irregular shapes develop. Formerly the trimming of these sheets was performed under the power punch. They are now cut with the oxy-acetylene torch which reduces the cost and saves considerable time.

The question of whether the welding together of all the sheets in the firebox is better than the riveted process is now under consideration. We have partly welded fireboxes now in service and their performance so far is all that could be expected and we believe that by employing the long flange so that the weld is made between two rows of staybolts, almost perfect results can be obtained. The welding of these seams can be performed with either the oxy-acetylene or electric arc process. Fig. 3 illustrates the method of preparing the seams for welding and in Fig. 4 the completed welds.

In removing the mudring from the boiler we very often find the bottom of the ring in poor condition due to corrosion. The sharp corner of the mudring in many instances is eaten away. We build up the corners and all flat surfaces where corrosion has taken place. Such a job is shown in Fig. 5.

After the inside firebox is removed from the boiler the staybolts still remain in the outside wrapper sheet. To remove these bolts the oxy-acetylene torch is employed to burn the bolt half way through the sheet; the bolt is then hot enough in the sheet so that it can be worked out by a helper who uses a short length of pipe for this purpose. This method of removing staybolts from side sheets is fast and is an improvement over the old method of drilling them out.

We apply a great many flexible staybolts to locomotive boilers, the sleeves of which were formerly screwed into the outside wrapper sheet, which is rather an expensive operation. The new style sleeve is ball seated and welded to the wrapper sheet by the electric arc process (Fig. 6). The oxy-acetylene process could not be employed on this class of work as on account of the diffused heat, the sleeve and sheet would have a tendency to warp. A particularly advantageous feature of the electric arc weld is afforded through the concentration of the intense heat in a small area enabling it to be applied just where it is needed without heating up so much of the adjacent material.

In welding firedoor seams the practice of some roads is to prepare the door hole seam as ordinarily done for plugs or rivets and then lap weld the flange to the back head. The method followed by the Southern Pacific is to butt the flanges of the back head and door sheet, and weld with either the electric arc or oxy-acetylene process. We have been following this process for several years and have never experienced any trouble with this method of welding these door holes.

When the bottom of the tube sheet is badly corroded and cracked it can be repaired. If the welding process was not available we would find it necessary to remove the entire sheet, which would cause considerable delay and add greatly to the cost of making repairs to this boiler. The repairs are made by cutting out the lower section of the sheet leaving the dry pipe and header in place and welding in a new section (Fig. 7).

Defects that develop in the firebox sheets are repaired with both oxy-acetylene and electric arc processes where new half side or tube sheets are applied. The defective parts are cut out with the oxy-acetylene torch and the electric arc is employed almost exclusively in welding in the sheets.

Another operation in which the electric arc has been employed to great advantage in railroad shops is in the maintenance of boiler tubes. Tubes are applied in the boiler in the usual manner and placed in service. After they have been in service a certain period or when they show signs of leaking the locomotive is held and the tubes are given a thorough working, then the sheets are roughened or sand blasted and the tubes welded to the sheet (Fig. 8). We find this method has given excellent results.

There are many other articles repaired in the boiler shop by the electric arc and oxy-acetylene processes. An example is a bail for a dragline bucket. This bail came in the boiler shop broken in several places. We applied a 1 inch reinforcing plate on the bottom side and welded it all around on inside and outside edges with the electric arc process thus insuring a strong durable job which will stand up to the very heavy service imposed upon it.

Fig. 9 shows a patch welded in outside side sheet of a locomotive boiler, also shows new bottom portion of outside wrapper sheet welded at top edge, full length of firebox.

Patches in boilers now welded in place were formerly applied with rivets or plugs and the joints very often interfered with other parts of the machinery. The welded joint overcomes that difficulty, the seams being practically same thickness as the sheet.

Fig. 10 shows the preparation and method of holding sleeves while welding, and Fig. 11 shows flexible staybolt sleeves welded on a locomotive boiler. After holes are drilled and countersunk to suit sleeves the surface surrounding the holes is cleaned and roughened, which breaks away all scale and dirt on sheet and gives the welder a chance to do a much better job than would otherwise be possible.

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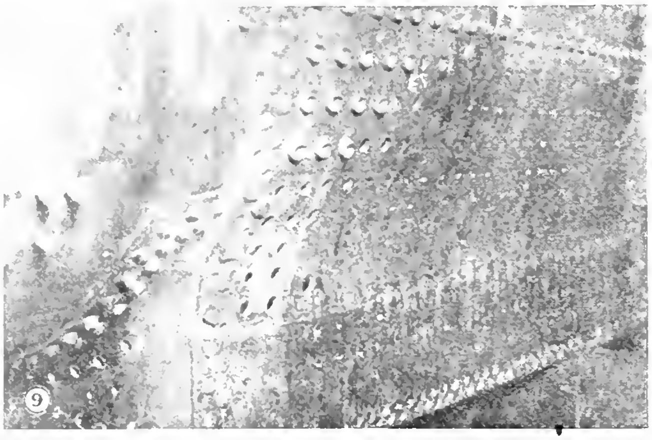
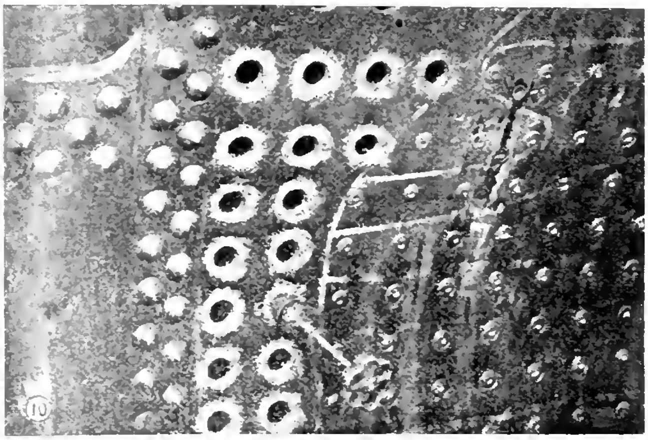
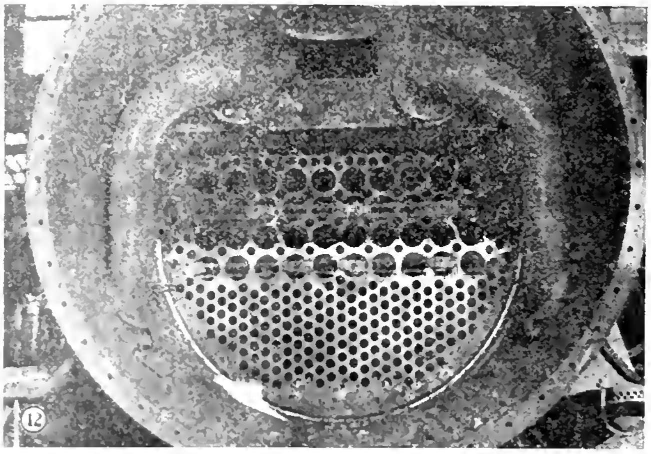
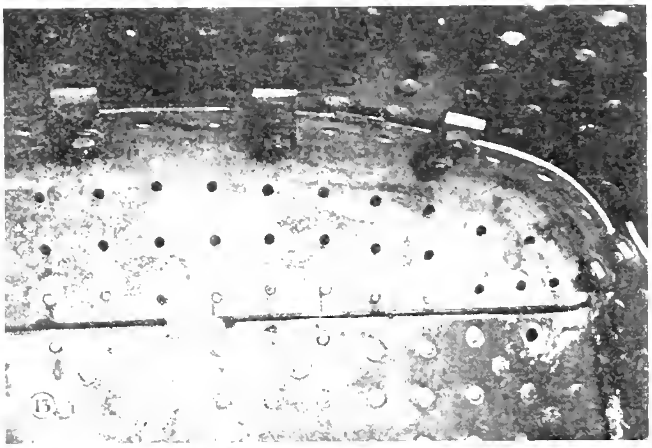
*Abstract of a paper presented before the San Francisco section of the American Welding Society, by H. J. McCracken and F. J. Hickey.

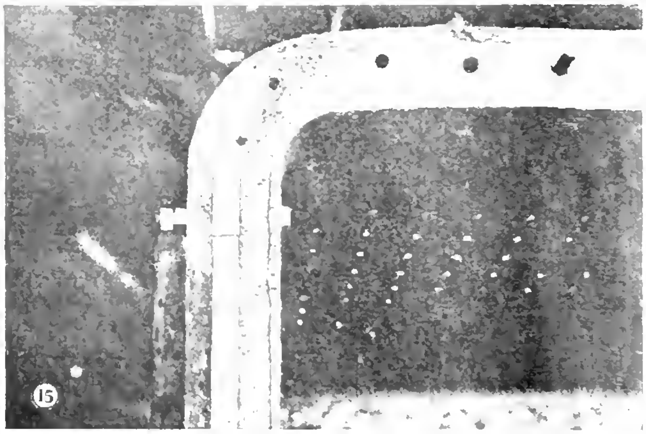



Fig. 9.—Side Sheet Patch. Fig. 10.—Method of Holding Sleeves While Welding. Fig. 11.—Sleeves Welded in Place. Fig. 12.—New Section Welded in Flue Sheet. Fig. 13.—Patch at Top of Door Sheet. Fig. 14.—Door Sheet After Welding. Fig. 15.—Mud Ring Welding Repair. Fig. 16.—Welding Used to Advantage on Tube Work of This Kind.

Both superheater and small flues are electric welded around the beads, which method we have been following in all our shops for some time with very satisfactory results. As all railroad mechanical men know there has been very little if any improvement made in the method of applying and setting flues for the past 30 years or more, and flues will leak, very often causing delay to a train.

Welds across the center of front flue sheet on 2-10-2 class locomotives are shown in Fig. 12, the lower portion of the sheet being new.

A method of applying a patch to the top of a door sheet is shown in Fig. 13. The patch was necessary on account of lap cracks and because the sheet was pitted in the knuckle. This patch as shown has been tack welded in several places in order that bolts and clamps may be removed. The same door sheet after welding is shown in Fig. 14.

The most successful applications of welding undoubtedly have been in places where thorough supervision and training of welders have been carried on. No matter what kind of material is to be welded, or what the type of welding is, the reliability of the weld rests in a large degree with the operator.

Careful examination and inspection of the welded joint is of the utmost importance. There are certain factors which determine the physical characteristics of the weld. First—examination of the weld by visual means. Second—The edges of the deposited metal should be chipped with a cold chisel or tried with a calking tool to determine the relative adhesion of deposit. Third—Pulling apart welded sections cut from the finished product. Fourth—The bending or breaking test. Tests should be made frequently to check up the operator's work.

Second Revision of the A. S. M. E. Boiler Code

Continuation of Proposed Changes in Provisions Dealing with the Construction of Power Boilers

The first section of the revised Boiler Code was published on page 233 of the August, 1922, issue of The Boiler Maker; the second section appeared on page 281 of the October issue. Below a continuation of the work of the committee on revision is given.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th street, New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Preamble:—Add the Following to the Preamble:

THE COMMITTEE DOES NOT EXPRESS OPINIONS ON TYPES OF BOILERS OR APPARATUS, NOR APPROVE OR DISAPPROVE OF ANY GENERAL DESIGN OR ESTABLISH WORKING PRESSURES THAT MAY BE CARRIED FOR SPECIFIC DESIGNS. FOR EXAMPLE, SHOULD A BOILER BE SUBMITTED BY A TRADE NAME OR THAT OF THE MANUFACTURER FOR APPROVAL OF THE BOILER CODE COMMITTEE, THE BOILER CODE COMMITTEE WOULD NOT EXPRESS ITS APPROVAL OR DISAPPROVAL. THE BOILER CODE COMMITTEE WOULD, HOWEVER, STAND READY TO INTERPRET ANY ONE OF THE RULES OF THE CODE AS APPLIED TO THE BOILER, BUT IT WOULD NOT SET THE PRESSURE THAT COULD BE CARRIED NOR PASS ANY OPINION IN REGARD TO THE MERITS OF A BOILER OR APPARATUS.

Note—Matter in small caps—added matter; matter in brackets—to be deleted.

Par. 1 Revised:

1 Specifications are given in these Rules for the important materials used in the construction of boilers and where given, the materials shall conform thereto. IF, IN THE DEVELOPMENT OF THE ART OF BOILER CONSTRUCTION, OTHER MATERIALS THAN THOSE HEREIN DESCRIBED BECOME AVAILABLE, SPECIFICATIONS FOR THE SAME MAY BE SUBMITTED FOR CONSIDERATION AND APPROVAL.

Par. 11 Revised:

11 Pressure parts of superheaters, separately fired or attached to stationary boilers, unless of the locomotive type, shall be of wrought steel, PUDDLED OR KNOBBLED CHARCOAL WROUGHT IRON, or cast steel of Class B grade, as designated in the Specifications for Steel Castings.

Par. 19 Add the Following to this Paragraph:

FOR PLATES OVER 1 IN. IN THICKNESS, WHERE THE SHEET IS HEAVIER THAN ORDINARILY REQUIRED IN ORDER TO AFFORD GREATER STRENGTH OF TUBE-HOLE LIGAMENTS, THE BUTT STRAPS MAY BE PROPORTIONED IN ACCORDANCE WITH THE *required* THICKNESS, BUT IN NO CASE MAY THEY BE LESS THAN ONE-HALF THE PLATE THICKNESS.

Par. 21 Revised:

21 *Tubes for Watertube Boilers.* The maximum allowable working pressures for tubes used in watertube boilers shall be for the various diameters and gages measured by Birmingham wire gage, as given in Table 2. REDRAWN PIPE NOT TO EXCEED 1½ INCH STANDARD PIPE SIZE WHICH MEETS THE PIPE SPECIFICATION, MAY BE USED FOR WATERTUBE BOILERS FOR A WORKING PRESSURE NOT TO EXCEED 200 POUNDS PER SQUARE INCH, WHEN SCREWED IN THE SHEET, PROVIDED THE WALL THICKNESS IS AT LEAST 50 PERCENT GREATER THAN THE WALL THICKNESS REQUIRED BY TABLE 2.

Par. 182 Add the Following to Revised Form as Published in the July Issue of Mechanical Engineering:

THE BACK PITCH OF TUBE HOLES OR RIVETS SHALL BE MEASURED EITHER ON THE FLAT PLATE BEFORE ROLLING, OR ON THE MEDIAN LINE AFTER ROLLING.

PAR. 185 REVISED:

185 When shell plates exceed 9/16 inch in thickness in horizontal-return-tubular boilers, the portion of the SHELL plate [s] forming the laps of the circumferential joints, where exposed to the fire or products of combustion, shall be planed or milled down as shown in Fig. 8, to A THICKNESS OF NOT OVER 1/2 inch [in thickness], provided the requirement in Par. 184 is complied with.

PAR. 187 CHANGE PARS. 187 AND 188 TO PARS. 188*a* AND 188*b* AND INSERT A NEW PAR. 187 AS FOLLOWS:

187 *Seamless Construction.* DRUMS, SHELLS OR DOMES MAY BE OF SEAMLESS DRAWN CONSTRUCTION WITH OR WITHOUT INTEGRAL HEADS PROVIDED THE MATERIAL FROM WHICH THEY ARE FORMED CONFORMS TO THE REQUIREMENTS OF ANY ONE OF THE SPECIFICATIONS IN THE CODE FOR SHELL MATERIAL.

PAR. 193 CHANGE PAR. 193 TO PAR. 192*d* AND INSERT NEW PAR. 193 AS FOLLOWS:

193 IN APPLYING REINFORCING PLATES TO THE DRUMS OF WATERTUBE BOILERS TO STRENGTHEN THE SHELL WHERE THE TUBES ENTER, THEY SHALL BE RIVETED TO THE SHELL, AND THE TUBES SHALL BE EXPANDED INTO THE INNER AND OUTER PLATES SO THAT THE RIVETS AND TUBES WILL HOLD THE PLATES TOGETHER IN ACCORDANCE WITH THE RULES FOR STAYED SURFACES.

THE SPACING OF THE RIVETS WITH RESPECT TO THE TUBES SHALL CONFORM TO PAR. 199 FOR STAYED SURFACES, USING A VALUE OF 135 FOR C, AND SHALL BE BASED ON A UNIT PRESSURE EQUAL TO THE PRESSURE THAT CAN BE CARRIED BY THE INNER PLATE WITH A FACTOR OF SAFETY OF 5.

(NOTE: WHERE A REINFORCING PLATE IS INSIDE THE STEAM DRUM IT IS THE INNER PLATE; WHERE IT IS OUTSIDE AND THERE IS NO INNER REINFORCING PLATE, THE UNREINFORCED SHELL OF THE DRUM IS THE INNER PLATE.)

THE TENSION IN RIVETS AND TUBES SHALL CONFORM TO PARS. 220 AND 232.

THE COMBINED DRUM SHELL AND REINFORCING PLATE OR PLATES SHALL HAVE A FACTOR OF SAFETY OF NOT LESS THAN 5 IN THE LIGAMENTS, WHEN CALCULATED IN ACCORDANCE WITH PAR. 192, ALSO IN RIVET CONNECTIONS. WHEN REINFORCING PLATES OR BUTT STRAPS ARE EXPOSED TO FLAME OR GAS OF THE EQUIVALENT TEMPERATURE, THE JOINTS SHALL BE PROTECTED THEREFROM.

PAR. 195 REVISED:

195 [Convex Heads.] The thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + 1/8$$

where;

t = thickness of plate, inches.

P = maximum allowable working pressure, pounds per square inch.

TS = tensile strength, pounds per square inch.

L = radius to which the head is dished, inches.

Where two radii are used the longer shall be taken as the value of L in the formula.

Where the radius is less than 80 percent of the diameter of the shell or drum to which the head is attached the thickness shall be at least that found by the formula by making L equal to 80 percent of the diameter of the shell or drum.

[Concave Heads.] Dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for heads of the same dimensions with the pressure on the concave side.

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than 1/8 inch over that called for by the formula. Where a dished head has a flanged opening supported by an attached flue, the increase of 1/8 inch in thickness is not required. IF MORE THAN ONE MANHOLE OPENING IS INSERTED, THE MINIMUM DISTANCE BETWEEN THE OPENINGS SHALL BE NOT LESS THAN ONE-FOURTH OF THE OUTSIDE DIAMETER OF THE HEAD.

PAR. 199 REVISED:

199 The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

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

where

P = maximum allowable working pressure, pounds per square inch.

T = thickness of plate in *sixteenths* of an inch.

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches.

C = 112 for stays screwed through plates not over 7/16 inch thick with ends riveted over.

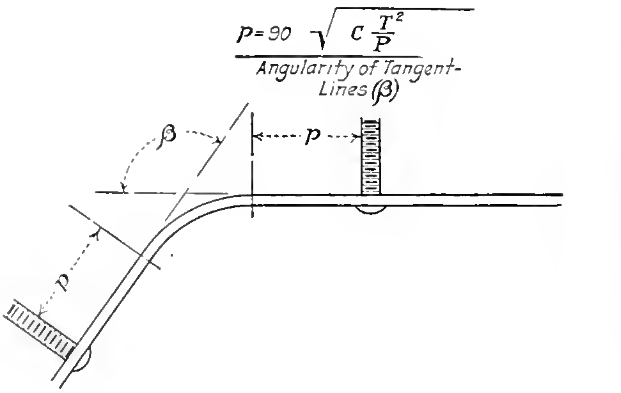
C = 120 for stays screwed through plates over 7/16 inch thick with ends riveted over.

C = 135 for stays screwed through plates and fitted with single nuts outside of plate OR WITH INSIDE AND OUTSIDE NUTS, OMITTING WASHERS.

C = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over said heads being made to have a true bearing on the plate.

C = 175 for stays fitted with inside and outside nuts and outside STEEL washers where the diameter of washers is not less than 0.4 p and thickness not less than T.

FOR STAYS AT THE UPPER CORNERS OF FIREBOXES THE PITCH FROM THE STAYBOLT NEXT TO THE CORNER TO THE POINT OF TANGENCY OF THE CORNER CURVE SHOULD BE.



If a flat boiler plate not less than 3/8 inch thick is strengthened with a doubling plate covering the full area of the stayed surface and securely riveted thereto and having a thickness of not less than 2/3 T, then the value of T in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plate but not more than one and one-half times the thickness of the boiler plate, and the value of C given above may also be increased 15 percent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

Acceptable proportions for the ends of through stays with washers are indicated in Fig. 14.

FIG. 14 REVISE SIDE EXPLANATION TO READ:

Not less than 2½ Diameters of Bolt AS MEASURED ON THE OUTSIDE OF THE THREADED PORTION but must be 0.4 Pitch of Stays if C = 175.

PAR. 196 REVISED:

196 When dished heads are of a less thickness than called for by Par. 195, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form. IF A DISHED HEAD IS FORMED WITH A FLATTENED SPOT OR SURFACE FOR THE ATTACHMENT OF A CONNECTION OR FLANGE, THE DIAMETER OF THE FLAT SPOT SHOULD NOT EXCEED THE VALUE OF p AS GIVEN IN THE FORMULA IN PAR. 199 OR IN TABLE 4, FOR THE PRESSURE AND THICKNESS OF HEAD INVOLVED.

PAR. 200 REVISED:

200 *Staybolts.* The ends of [screwed] staybolts OR STAYS SCREWED THROUGH PLATES, shall be riveted over or upset by equivalent process OR FITTED WITH NUTS. The outside ends of solid staybolts, 8 inches and less in length, shall be drilled with a hole at least 3/16 inch diameter to a depth extending at least ½ inch beyond the inside of the plates, or hollow staybolts may be used. On boilers having a grate area not exceeding 15 square feet, or the equivalent in gas- or oil-fired boilers, the drilling of staybolts is optional. Solid staybolts over 8 inches long, and flexible staybolts of either the jointed or ball-and-socket type, need not be drilled. Staybolts used in waterlegs of watertube boilers shall be hollow or drilled at both ends, irrespective of their length. ALL STAYBOLTS NOT NORMAL TO THE STAYED SURFACE SHALL HAVE THREE ENGAGING THREADS OF WHICH ONE SHALL BE A FULL THREAD.

PAR. 208 REVISED:

208 The diameter of a screw stay shall be taken at the bottom of the thread or WHEREVER IT IS OF [provided this is] the least diameter.

PAR. 212 REVISED:

212*a* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays OR RIVETED LONGITUDINAL JOINT OR OTHER CONSTRUCTION EXCEPT HAND-HOLES. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. 199, using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays OR RIVETED LONGITUDINAL JOINT OR OTHER CONSTRUCTION EXCEPT HAND-HOLES. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 5, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

PAR. 212*b* ADD THE FOLLOWING TO THIS PARAGRAPH:

THE ABOVE FORMULA APPLIES TO THE LONGITUDINAL CENTER SECTION OF THE WRAPPER SHEET, AND IN CASES WHERE E IS REDUCED AT ANOTHER SECTION, THE MAXIMUM ALLOWABLE WORKING PRESSURE BASED ON THE STRENGTH AT THAT SECTION, MAY BE INCREASED IN THE PROPORTION THAT THE DISTANCE FROM THE WRAPPER SHEET TO THE TOP OF THE CROWN SHEET AT THE CENTER, BEARS TO THE DISTANCE, MEASURED ON A RADIAL LINE THROUGH THE OTHER SECTION, FROM THE WRAPPER SHEET TO A LINE TANGENT TO THE CROWN SHEET AND AT RIGHT ANGLES TO THE RADIAL LINE. (SEE FIG. 14½.)

PAR. 216 REVISED:

216 Stays shall be used in the tube sheets of a firetube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 4. That part of the tube sheet which comes between the tubes and the shell need not be stayed, if the GREATEST distance [to the nearest tangent common to two tube holes when] measured ALONG A RADIAL LINE FROM THE INNER SURFACE OF THE SHELL TO THE CENTER POINT OF THE TANGENT COMMON TO ANY TWO TUBE HOLES ON THE SHELL SIDE OF SUCH [on any radius of the tube sheet that intersects the tangent between the] holes does not exceed 1.25 TIMES THE [this] maximum pitch OF STAYBOLTS FOR THE CORRESPONDING PLATE THICKNESS AND PRESSURE GIVEN IN TABLE 4 [by more than 3 inches]. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

PAR. 218 REVISED:

218 When STAYS ARE REQUIRED the portion of the head S below the tubes in a horizontal-return-tubular boiler SHALL BE SUPPORTED BY THROUGH STAYS WITH NUTS AT THE FRONT HEAD. WHERE a manhole opening is provided [with] the flange of which is formed from the solid plate and turned inward to a depth of not less than three times the required thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. 16, may be reduced by 100 square inches. [The surface around the manhole shall be supported by through stays with nuts inside and outside at the front head.]

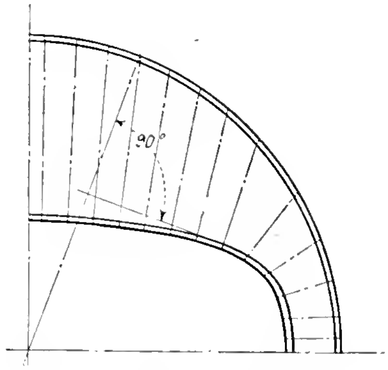


Fig. 14½.—Staying for Wrapper Sheet of Locomotive Boiler

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 inches at any point.

TABLE 5 PLACE AN ASTERISK AFTER THE WORD "DIAMETER" EACH TIME IT APPEARS IN THIS TABLE, AND INSERT THE FOLLOWING NOTE AT BOTTOM OF TABLE: *DIAMETERS TAKEN AT BODY OF STAY.

PAR. 230 ADD THE FOLLOWING TO THIS PARAGRAPH:

IN A FORM OF REINFORCEMENT FOR CROWN SHEETS WHERE THE TOP SHEET OF THE FIREBOX IS A PART OF A TRUE CIRCLE NOT EXCEEDING 120 DEGREES IN ARC, AND IS BRACED WITH ARCH BARS EXTENDING OVER THE TOP AND DOWN BELOW THE TOP ROW OF STAYBOLTS AT THE SIDES, THESE ARCH BARS BEING RIVETED TO THE WATER SIDE OF THE CROWN SHEET THROUGH THIMBLES, THE MAXIMUM ALLOWABLE WORKING pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter and length by the formula in Par. 239, the pressure P_1 determined from the following formula, which is a modification of that in Par. 241, section *a*

$$P_1 = 10,000,000 \frac{b \times d^3}{p \times D^3}$$

where

b = net width of crown bar, inch
d = depth of crown bar, inch
p = longitudinal pitch of crown bar, inch
D = outside diameter of furnace, inch.

Provided that the maximum allowable working pressure must not exceed that determined by the formula for furnaces of the Adamson type, in Par. 242 when L is made equal to p, and also provided that the diameter of the holes for the staybolts in the crown bars does not exceed $1/3\ b$, and the cross-sectional area of the crown bars is not less than 4 square inches, Par. 199 would govern the spacing of the staybolts, rivets or bolts attaching the sheet to the bars, and Par. 212*b* the size of the staybolts, rivets or bolts.

Par. 231 Revised:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38-inch diameter at the large end, may be used without stays if computed by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end; provided that the longitudinal joint conforms to the requirements of Par. 239.

b When over 38 inches in diameter at the large end, that portion which is over 30 inches in diameter shall be [fully] supported by staybolts or gussets. If supported by staybolts Par. 212D shall apply. If supported by gussets the spacing of the rivets attaching the gussets to the combustion chamber shall not exceed the staybolt spacing given by Par. 212D. [to conform to the provisions for staying flat surfaces. In this case.] The top row of staybolts shall be at a point where the cone top is 30 inches or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

Par. 239 Revised:

239 *PLAIN CIRCULAR FURNACES.* The Following Rules Apply in General to Unstayed Circular Furnaces:

a-1 The longitudinal joint may be riveted or lap welded by the forging process, or the furnace may be of seamless construction

a-2 The longitudinal joint if riveted shall have an efficiency greater than

$$\frac{P \times D}{1,250 \times T}$$

a-3 The walls shall not be less than 5/16 inches thick

a-4 Butt strap seams shall be used only where they are protected from contact with the fire

a-5 The furnace may be of any length or height

Par. 240 Omit This Paragraph and Replace By the Following:

240 The Following Rules Apply Specifically to Unstayed Circular Furnaces 12 Inches in Diameter and Over:

A 12 inches to 18 inches outside diameter, inclusive.

b-1 A riveted longitudinal joint may be of the lap type

b-2 The maximum allowable working pressure for furnaces not more than four and a half diameters in length or height shall be determined by formulae *a* and *b* as follows:

a Where the length does not exceed 120 times the thickness of the plate

$$P = \frac{51.5}{D} [(18.75 \times T) - (1.03 \times L)]$$

b Where the length exceeds 120 times the thickness of the plate;

$$P = \frac{4,250 \times T^2}{L \times D}$$

where

P = maximum allowable working pressure, pound per square inch
D = outside diameter of furnace, inches
L = total length of furnace between centers of head rivet seams (not length of a section), inches
T = thickness of furnace walls, in sixteenths of an inch

b-3 The maximum allowable working pressure for furnaces over four and one-half diameters in length or height shall be determined in accordance with Par. 241.

B Over 18 inches outside diameter to and including 30 inches inside diameter.

c-1 A riveted longitudinal joint may be of the lap type

c-2 The maximum allowable working pressure shall be determined by formulae *a* and *b* in A; if over six diameters in length or height, L in the formula shall be taken as six times the diameter.

C Over 30 inches inside diameter to and including 36 inches inside diameter.

d-1 A riveted longitudinal joint may be of the lap type provided the furnace does not exceed 36 inches in length or height

d-2 If the length of a horizontal furnace exceeds 36 inches and the joint is riveted, a butt and single or double strap construction shall be used and shall be located below the grate

d-3 The maximum allowable working pressure shall be determined by formulae *a* and *b* in A; if over six diameters in length L in the formula shall be taken six times the diameter.

D Over 36 inches inside diameter to and including 38 inches outside diameter.

e-1 When riveted the longitudinal joint of a horizontal furnace shall be butt and single or double strap construction and shall be located below the grate

e-2 The maximum allowable working pressure shall be determined by formulae *a* and *b* in A; if over six diameters in length L in the formula shall be taken as six times the diameter.

[*Additional revisions of the A.S.M.E. Boiler Code will appear in the April issue of* The Boiler Maker.]

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That the demand for boilers is better now than at any time since the peak production of the early months of 1920 was the general sentiment expressed at the mid-winter meeting of the American Boiler Manufacturers' Association, held February 12 at the Hotel Astor, New York City. Not only has the business of boiler construction been improving rapidly but all signs indicate that the volume will continue for at least six months. Practically all plants are now averaging about 75 percent of their normal activity and several show a production above this figure.

The fact that the majority of companies are ordering material only as it is needed and not relying on reserve supplies indicates that the increased demand for boiler construction will be reflected in a steady volume of orders for material produced by the supply companies. Incidentally, plate, tank and steel heating boiler fabrication have been found an excellent source of new business by several companies.

It developed at the meeting that men are needed in increasing numbers for both skilled and unskilled positions in the shops. This should prove a great incentive to young men who have recently entered the industry and to the older men who have been holding minor positions in the shop. There are ways and means available for such individuals to fit themselves for the more important work that requires special study and experience if they are willing to spend the time and effort required in training for advancement. As a matter of fact the opportunities in the boiler manufacturing industry for men with ambition has never been better.

An important question brought up at the American Boiler Manufacturers' Association meeting for discussion was the matter of establishing a standard basis for rating boilers. With the exception of the manufacturers of watertube boilers, no common understanding exists of the number of square feet of heating surface that is equivalent to one boiler horsepower. Manufacturers of the various other type boilers differ to a wide extent in their usage of the equivalent heating surface values for boiler horsepower.

Heating surface in a boiler has been defined as a surface having water on one side and heated gases on the other. It is understood that the Power Test Code of the American Society of Mechanical Engineers will establish the exact definition of heating surface and will eliminate the term "boiler horsepower" from the Code as having lost its significance in modern methods of boiler design and operation.

The term "horsepower" as a means of rating boilers is familiar to many clients of horizontal return tubular and other power boiler manufacturers in specifying boiler units and should, therefore, be continued. However, the relation between heating surface and boiler horsepower should be definitely established so that all estimates for bids may be made on the same basis.

The work of investigating this matter more fully will be carried out by a committee of the American Boiler Manufacturers' Association and definite action will probably be taken on the matter at the June meeting which will be held at "The Homestead," Hot Springs, Va., June 4, 5 and 6. All members of the association who did not attend the winter meeting should be prepared to express an opinion on the subject when it is again brought up for discussion.

From the many invitations received by the American Boiler Manufacturers' Association to co-operate with allied associations and to maintain representation on the committees of various societies working towards simplification or standardization in the industries, it is evident that the prestige and influence of the association are rapidly increasing. However, there are many important boiler manufacturing concerns in the country which do not belong to the association and, as the interests of the entire industry are being served by its efforts, these companies should lend their support to the work of the association. Immediately after the recent meeting of the association the secretary forwarded membership applications to all present members with the request that they interest other concerns in the work of the organization. All companies wishing to obtain detailed information on the matter may communicate with the secretary of the American Boiler Manufacturers' Association, H. N. Covell, 191 Dikeman street, Brooklyn, N. Y.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Waste Heat Economizer and Circulating Device

A new waste heat economizing and circulating device is being put on the market by the Mitchell Boiler and Engineering Company, Mitchell, Indiana.

The device consists of a front and rear header with water tubes connecting them, disposed at the sides in the space between the boiler and its setting.

All material and details of construction conform to the boiler code of the American Society of Mechanical Engineers, and the various state laws.

The front header is attached to the boiler by two 2½-inch connecting pipes. The rear connections are made by two 2½-inch connecting pipes from the top of the rear header to each side of the boiler at the water level. The rear header is provided with two 2-inch blow-off pipes, and the regular boiler blow-off is connected to the bottom of the outside of the rear header. The thickness of the plate and staybolts conform to the safe working pressure of the boiler.

For each tube hole in the sheet of each header there is a corresponding hole in the outside sheet fitted with a hand plate.

Each unit is shipped in a knocked-down condition, the separate parts being the assembled headers, the separate tubes, connecting pipes, and boiler flanges. Each unit for a boiler already set is made to the measurements of the boiler setting. When ready to be installed the boiler front is taken down, front arch removed and rear wall removed. The headers are then placed in position and hand plates removed. The tubes are entered through the hand holes, either at front or rear, and rolled in as with any other water tube boiler. The connections to the boiler are then made and hand plates replaced. The unit is then ready for the hydrostatic test.

When the regular boiler front is replaced, and a thin wall built up at the rear to protect the rear sheet from cold air, the entire unit is invisible, except the hand plates.

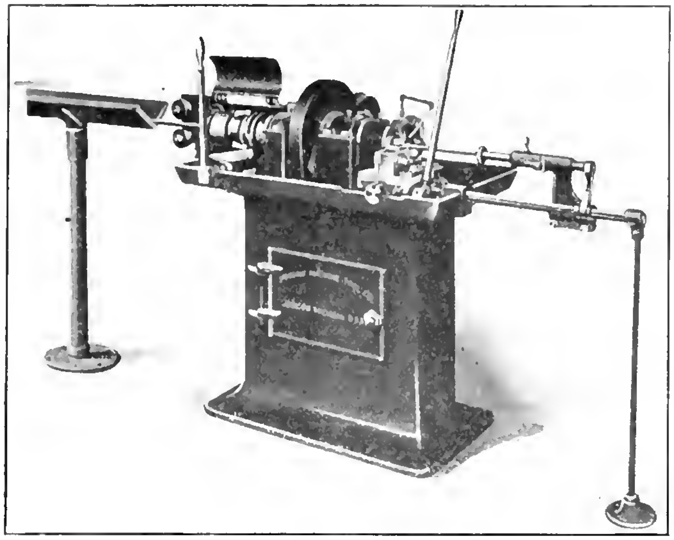
In aiding circulation the device functions so that the water travels from the economizer into the boiler from the top of the rear header; thence out of the boiler proper, through connecting pipes, to the bottom of the front header; thence back through the tubes at each side into the rear header, and then out from the top of it to the boiler again, and so the circulation continues.

Cutting-Off Machine Provided With Roller Feed

The machine for cutting off pipe, tubing and solid bars, made by the Modern Machine Tool Company, Jackson, Mich., has recently been provided with a double live roller feed. This arrangement, applicable to 2-inch and 3-inch machines, feeds the stock through the spindle against an automatic stop for gaging the length of pieces to be cut off. The automatic stock stop is of the same general design as the old one, but is operated from the tube block. A plate, adjustable to take care of the tool setting for different sizes of stock, is attached to the right-hand side of the tool block and arranged with a lug to catch and rock the rocker block shown between the tool block and frame. As the tool block is moved out, removing the tool from the cut, the last ⅛ inch movement, the lug catches the rocker shaft and, through the lever and cam, rotates the stock stop throwing it out 3/16 inch. As soon as the tool block is fed in to start the cut, the spring brings the stop back to place clear of the work so that it will not wear and the work can drop away from the tool.

The double live roller feed for feeding stock through the spindle is driven through worm and gears from the cone pulley shaft. As the machine is slowed for large stock, it also slows up the speed of the feed. The feed rolls run continuously. They are so trunnioned and connected with the collet control lever shaft that the in-movements of the collet control lever opens the collet and brings the roll simultaneously up to the stock. A slight further pressure on the collet

Two Types of Water Tube Economizers for Horizontal Return Tubular Boilers



Modern Machine for Cutting Off Pipe, Tubing and Bar Stock

control lever feeds the stock through the spindle against the stop. The back movement of the collet lever throws the rolls clear of the stock and closes the collet.

The collet control has been changed by placing the control lever in a vertical position, with a toggle action applied in such a way as to do away with the greater part of the friction encountered on the old machine. The collet control lever operates a great deal easier than on the old machine even with the added work of controlling the feed. Moreover, the operator is saved three or four motions and one step for every piece he cuts off. This is evidently an important factor in working up large amounts of piping or bar stock as frequently is necessary in large railroad shops and particularly production departments.

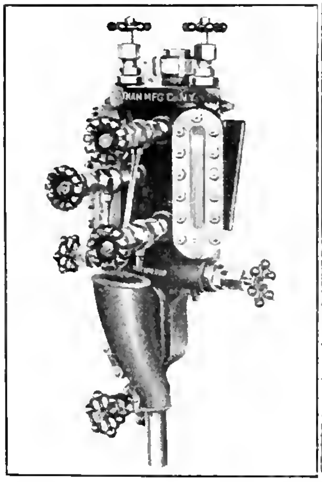
Water Columns for Locomotive Boilers

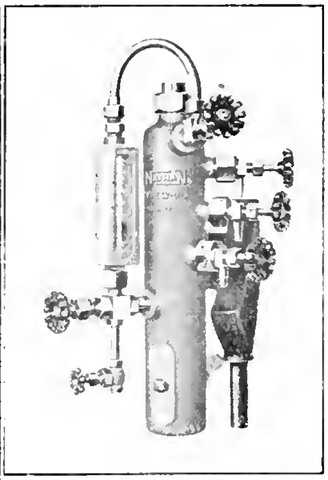
The two types of water columns illustrated are made by the Nathan Manufacturing Company, New York, and have been tested satisfactorily under actual service conditions. The type W-O-A water column (right) with tubular glass, which complies with recommendations contained in the last annual report of the chief inspector, Bureau of Locomotive Inspection, occupies but a minimum of space on the boiler. The body of the column is drawn in at the lower end and the cross section is reduced, without, however, interfering with the necessary volume of water entering the column. By this construction the column is fitted close to the back head, with sufficient room for substantial connection to the water space of the boiler. A further variation in the bottom extension of the water column is secured by elongated pads, thus permitting of application to almost any boiler. If necessary, special lengths may be provided for unusual installations.

Another feature of this type is the method of attaching the gage cock to the body of the column. By doing away with the usual shank of the gage cock, the distance which the spindle of the gage cock protrudes has been materially reduced. The gage cock is so constructed that it may be removed and replaced quickly with steam in the boiler. The water gage attached to the column and the column itself are provided with necessary drain valves for draining the water gage or the column, independently of each other.

The type W-B water column (left) differs from the one previously described in that it contains two reflex gages instead of the tubular gage. This type is a self-contained water column, comprising within itself the gage cocks and the water gage, eliminating the pipe connections and joints necessary with independent water gages attached to the column. It is equipped with reflex gages, with glasses embedded in the body of the column and so placed that the water level may be observed from both the engineer's and the fireman's side.

A special provision that will be appreciated is the bonnet attached to the upper and lower valve controlling the respective water glass compartments. These bonnets are provided with warning ports which will blow at all times except when the valves are wide open.





Nathan Type W-B and Type W-O-A Water Columns, Fitted with Reflex and Tubular Water Glasses Respectively

BUSINESS NOTES

W. A. Day has been appointed manager of sales for the territory north of the Ohio river for the Casey-Hedges Company, Chattanooga, Tenn., manufacturers of boilers, with headquarters in the Marquette building, Chicago.

At a recent meeting of the stockholders of the American Boiler Tube Thimble Company, Providence, R. I., the following officers were elected: President, William J. Greene; vice-president, Thomas P. Himes; treasurer and general manager, J. D. Cameron; secretary, M. E. Murray.

Several changes in the branch offices of the Westinghouse Electric & Manufacturing Company have been announced by W. S. Rugg, general sales manager of that company. C. V. Woodward has been appointed manager of the Baltimore, Md., office and F. C. Reed has been made manager of the Huntington, W. Va., office. R. J. Ross has been appointed assistant manager of the transportation division of the Philadelphia office, and W. F. James has been appointed manager of the industrial division of the Philadelphia office, succeeding R. F. Moon, who has resigned to accept the vice-presidency of the Atlantic Elevator Company, of New York.

The Uehling Instrument Company, Paterson, N. J., has appointed Charles J. Schmid in charge of sales in Greater New York and Long Island with headquarters at Paterson. Mitsui & Co. have just been appointed exclusive representatives in Japan and China. The head office of Mitsui & Company is at Tokio and its New York City branch office is at 65 Broadway. John E. Arnold, 15½ South Fourth street, Tulsa, Okla., has been appointed agent in charge of territory in the state of Oklahoma, and H. R. N. Johnson, 917-A Marquette avenue, Minneapolis, Minn., has been appointed agent, whose territory includes Minnesota, North Dakota and South Dakota.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Tank Support Calculations

Q.—Will you please publish in THE BOILER MAKER explanation for calculating the supports required for water tanks as shown in Figs. 1 and 2. The supports in both cases are of angle sections. Size and number of bolts, size of angles, plates, etc., to be given in calculations.—L.T.

A.—In the determination of structural members for the support of tanks, calculations involving the properties of structural sections are applied. For beams the strength is calculated by first finding the bending moment. Then the *section modulus* required in the beam is obtained by dividing the bending moment in inch tons by the safe stress of the material which for tension and compression is taken at 16,000 pounds per square inch. A beam is subjected to both compression and tension stresses. For a load uniformly distributed the bending moment is found from the formula:

$$\frac{W \times L}{8}$$

in which;

W = the load in pounds on the beam.

L = length of beam in inches.

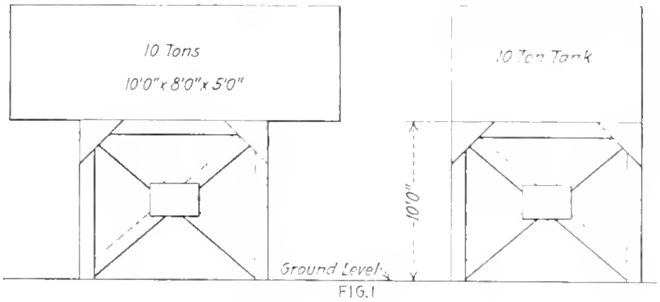
In the problem, Fig. 1, where the beams are of different lengths, say 10 feet for the long beams and 8 feet for the shorter, a greater load or deflection arises in the short beam. The load in such a case is determined, in Fig. 3, as follows:

$$\frac{8^4}{8^4 + 10^4} = \frac{4{,}096}{14{,}096} = 0.3$$

The load of 10 tons being uniformly distributed, each beam will carry the following loads:

On each 10-foot beam, $10{,}000 \times 0.3 = 3{,}000$ pounds.

On each 8-foot beam, $10{,}000 \times 0.7 = 7{,}000$ pounds.



Cross Beam Type of Tank Support

The bending moment of the 8-foot beam equals

$$\frac{W \times L}{8} = \frac{7{,}000 \times 8 \times 12}{8} = 84{,}000 \text{ pounds.}$$

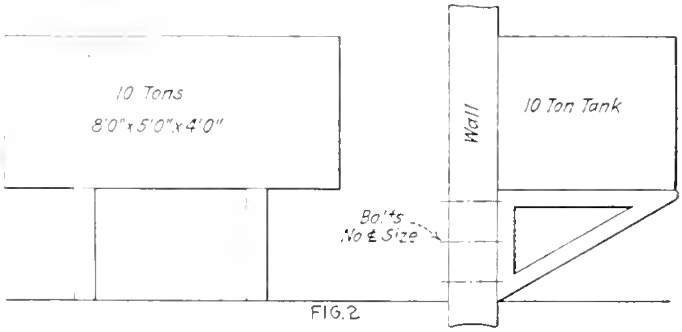
The section modulus equals $\frac{84{,}000}{16{,}000} = 5.25$.

From the structural handbooks a channel with the section modulus 5.25 has a depth of 7 inches and weighs 9¾ pounds per foot length approximately.

For a 10-foot span the bending moment equals

$$\frac{3{,}000 \times 10 \times 12}{8} = 45{,}000 \text{ pounds.}$$

Section modulus $= \frac{45{,}000}{16{,}000} = 2.81$. In this structure use the same size beam as for the 8-foot length.



Wall Supported Type of Tank

Design of Posts

In the calculation of the post supports the factors known as the radius of gyration and the ratio of the length to the least radius of gyration are applied. For structures of this kind the latter should not exceed 120 times the least radius of gyration. The load on each support is $\frac{20{,}000}{4} = 5{,}000$ pounds.

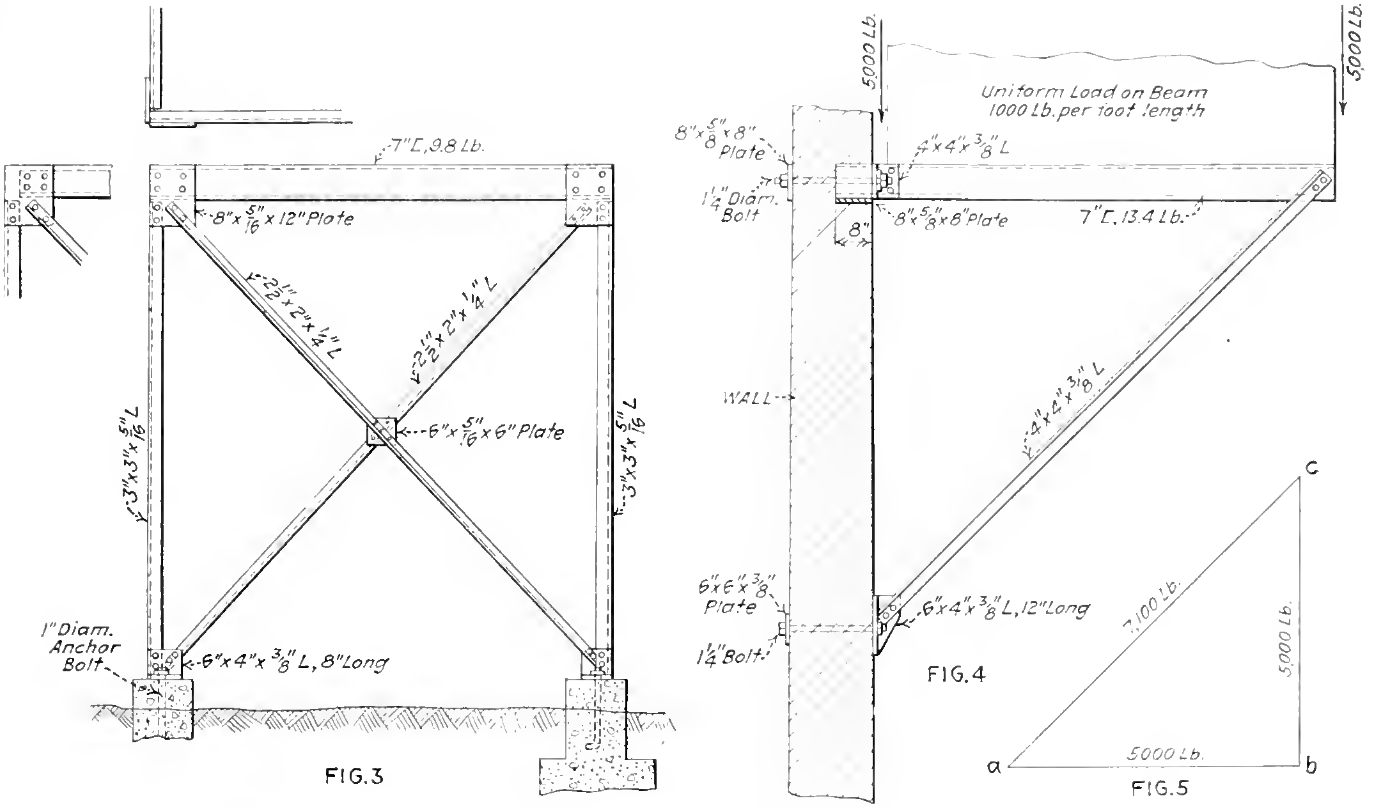
The length of the unsupported section of post in this case equals 9 feet = 108 inches. The unit stress in the post is determined from the formula $16{,}000 - 70\frac{l}{r}$, in which;

l = 108 inches, length of post.

r = least radius of gyration.

Assuming a 3-inch by 3-inch by 5/16 inch angle, the value of $r = 0.92$ and substituting the known values in the formula the unit stress equals $16{,}000 - 0.70 \times \frac{108}{0.92} = 7{,}000$.

The load on the support equals 5,000 pounds by dividing the load by the unit stress gives the cross-sectional area of the member required or $\frac{5,000}{7,000} = 0.7$ square inch. From the structural tables the area available in a 3-inch by 3-inch by 5/16-inch angle equals 1.78 square inches, which shows that the angle supports are heavy enough. Tie angles are used to hold the beams in alinement as indicated in Fig. 3.



Methods of Calculating Structural Members for Different Type Tank Supports

Design of Bracket Supports

The calculation of the beam for the bracket support, Fig. 2, is figured in a similar way. In this example the load of 10 tons is carried by two 8-foot beams. One end of each beam is set in the wall and the other end supported by angles connected to the wall by angle anchors. One-half of the load acts on the outer end of the beam, tending to pull out the end set in the wall, and to crush the diagonal angle supports. The size of the channel may be determined as already explained for Fig. 3. The unit stress in the diagonal angles is determined generally by the stress diagram, Fig. 5. Lay off the load of 5,000 pounds along the lines *a-b* and *b-c* to scale. The diagonal *a-c* is the stress on the diagonal angle which equals in this case 7,100 pounds.

The length of the support in this case equals $\sqrt{8^2 + 8^2} =$ 12.3 feet and the value of $\frac{l}{r}$ should not exceed 120. Therefore the radius of gyration equals $\frac{12.3}{120} \times 12 = 1.23$. From the tables of structural properties an angle 4 inches by 4 inches by 3/8 inch weighing 9.8 pounds per foot length meets the requirements.

The end of the beam in the wall should be held by an anchor bolt to resist a pull of 5,000 pounds. The safe tension stress per square inch considered is 16,000 pounds so a bolt 7/8-inch in diameter is sufficient. Cross sectional area of 7/8-inch bolt equals $7/8^2 \times 0.7854 = 0.6013$.

$0.6013 \times 16,000 = 9,620$ pounds unit tension stress a 7/8-inch bolt will safely stand. The rivets in the angle connections are in shear. The safe stress allowed in shear equals 10,000 pounds per square inch. The greatest shearing load in this case is 5,000 pounds. The gusset plates are riveted to the angles and channel in Fig. 3 with four 5/8-inch rivets. The cross sectional area of the 5/8-inch rivet is 0.3068 square inch.

$0.3068 \times 10,000 = 3,068$ pounds.

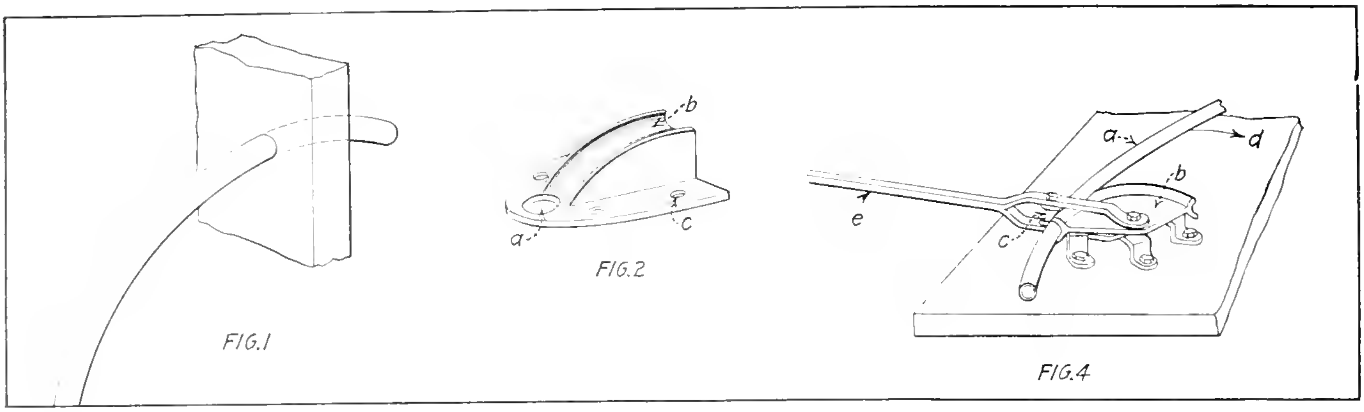
$3,068 \times 4 = 12,272$ pounds shearing value of rivets.

In Fig. 4, two 5/8-inch rivets are used to carry the shear load of 5,000 pounds as $3,068 \times 2 = 6,036$ pounds shearing strength.

Bending Pipe and Boiler Tubes

Q.—Would you please inform me through your Question Column of the rule for bending watertubes for a two-drum watertube boiler, to be bent to 36-inch radius; for instance, as in the two-drum bent tube boiler as made by George W. Ladd Company, or Erie City Iron Works? Please show how this is done and how one may find the center points whereby to inscribe the proper arcs.—T. T. P.

A.—Small pipe or tubes 2 1/2 inches in diameter and smaller can be bent cold by hand. Larger sizes are usually bent under pressure or by heating the metal at the point of bend. For hand bending use an arrangement as in the case of plank *a*, Fig. 1, inclined at a suitable angle in which is bored a hole to suit the diameter of the tube. A small clearance sufficient to allow the tubing to pass through the plank is allowed. When tubes 2 inches and larger are bent by this means, the tube section is liable to flatten and the inside of tube at the bend is likely to sink. To avoid this as much as possible the bend should be forced slowly to allow the metal to gradually form the required curvature. The bend should be made uniformly by shifting the tube at equal short spaces, thereby making the bend to a small degree throughout the entire length of the bend.



Three Forms of Bending Devices for Tubing

Curved formers are used for hot bending. One of the types suitable for this purpose is shown in Fig. 2. The base *a* is bolted to a substantial frame or table and the tube is inserted to engage with the hole *b* which holds the tube in place while the tube is bent over the curved form *c*. In hot bending, the tube section will flatten a trifle and the outside curved section will stretch, thinning the wall of the tube.

Using Roller Formers

Roller formers, Fig. 4, are better adapted for this work, as a more uniform bend can be made without deformation of the tube wall. The pipe *a* is inserted between the quadrant *b* and roller *c*. In bending, the pipe is pulled in the direction of the arrow *d* and the lever is pushed forward in the direction of arrow *e*.

Fig. 3 shows a watertube boiler with bent tubes partially installed. Where a large number of tubes are bent the manufacturer employs for this particular type a hydraulic bending machine shown in Fig. 5. The tubes are placed between suitable rollers and, by the use of a former operated under hydraulic pressure, the tubes are formed to the required curvature. All tubes are bent to a templet according to respective sizes indicated on the band opposite the operator.

In figuring the length of pipe for an inside radius, calculate the length to a radius equal to the inside radius plus one-half of the outside diameter of the pipe or tube. The length of the tubing in the bend would then depend on the arc length on the center of the tube.

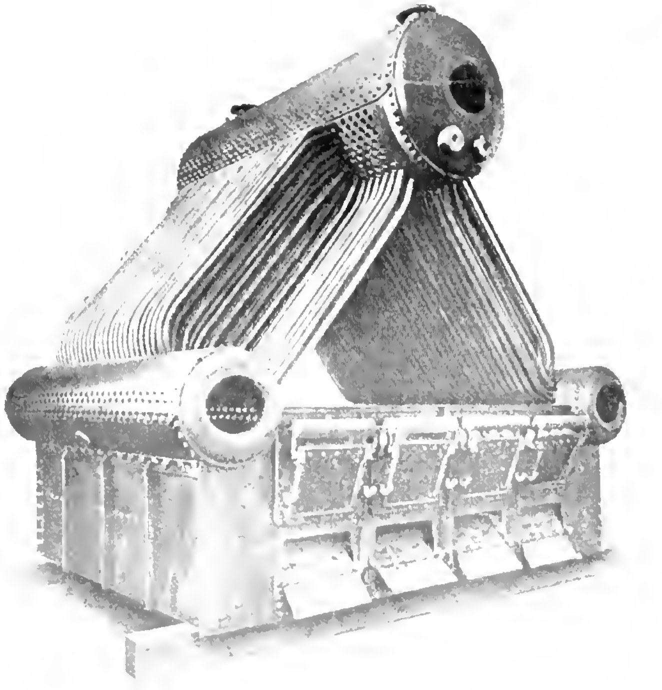


Fig. 3.—Watertube Boiler with Bent Tubes Under Process of Installation

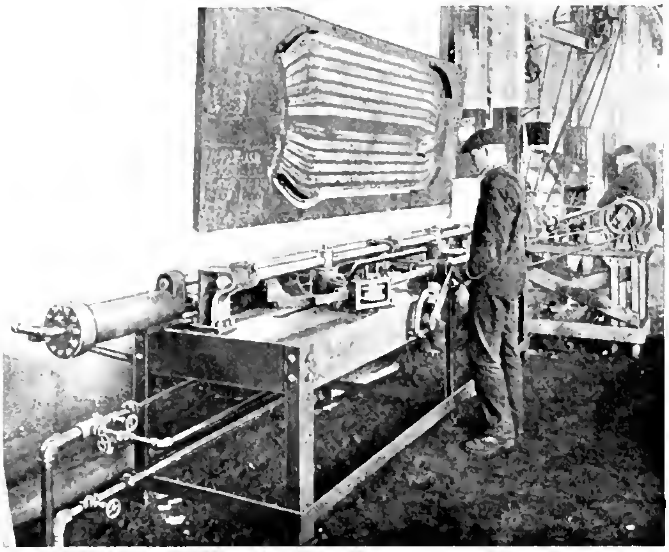


Fig. 5.—Type of Hydraulic Tube Bending Machine

Repairs Under Pressure

(*Continued from page 69*)

to stop this same leak, but they had not been successful. It is also stated that the joint was defective, and that to prevent similar accidents in the future, the entire pipe line was soon to be dismantled and examined.

Wherever this article comes to the attention of a man who is accustomed to repair vessels of any kind under pressure, we sincerely hope it may be the means of influencing him to discontinue the practice. We know very well that work of this sort is often done without disastrous results; but there are plenty of examples of fatal cases, and no man who persists in following the practice can tell when his turn may come. Neither has any employer a right to ask a man to risk his life in this way. Delays and shut-downs may cause extra expense, but this should not be considered where human life is endangered.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Firebox Type Boiler Failure Caused By Low Water

After reading an account of a boiler explosion at a saw mill at Edge Hill, Pa., the writer being a commissioned boiler inspector visited the scene of the disaster in order to investigate and if possible ascertain the cause of the explosion. I first interviewed the owner of the plant in an endeavor to obtain information as to the operating conditions, but was unsuccessful, the owner stating that he did not know anything about the boiler, not even the amount of pressure carried or allowed on it.

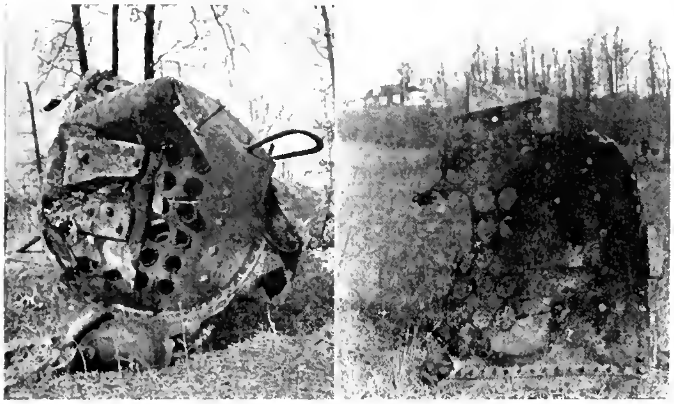


Fig. 1.—View of Smokebox End of Boiler and Tube Sheet 350 Yards from Point of Explosion

After interrogation on other points the owner informed me that the boiler had never been inspected by an authorized inspector since coming into his possession, and stated that he had purchased the boiler about six years ago, at which time he understood it to be about one year old.

I then visited the wreck and found the boiler to be of the portable threshing machine type with engine mounted on boiler shell; 36 inches diameter; 11 feet 10 inches overall length, estimated from the condition at about 12 years old; 0.25 inch shell plate, double riveted lap joints, 0.3125 inch tube sheet, pitch of rivets in longitudinal seam 3.25 inches, giving a joint efficiency of 72.8 percent. The boiler was equipped with a 2 inch lever safety valve which was found on the lot near the exploded boiler. The valve stem and other portions of the valve were carefully examined and found to be in good working condition.

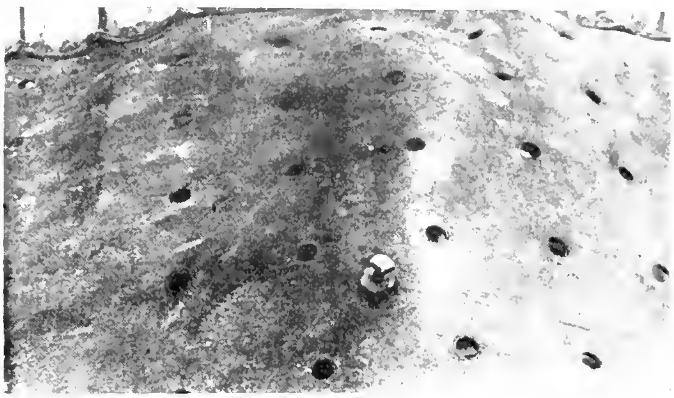


Fig. 3.—Defective Fusible Plug in Crown Sheet Which Contributed to Seriousness of Failure

A mark was found on the lever indicating the position of the weight. The lever was numbered 80 pounds but as no weight or ball was found or any other means of ascertaining just what weight was on the lever at time of the accident it is assumed that same was set to blow at 80 pounds pressure.

The boiler was blown a distance of about 100 feet into the air then describing an arc fell in a lot on the opposite side of a highway about 300 feet distant from its original

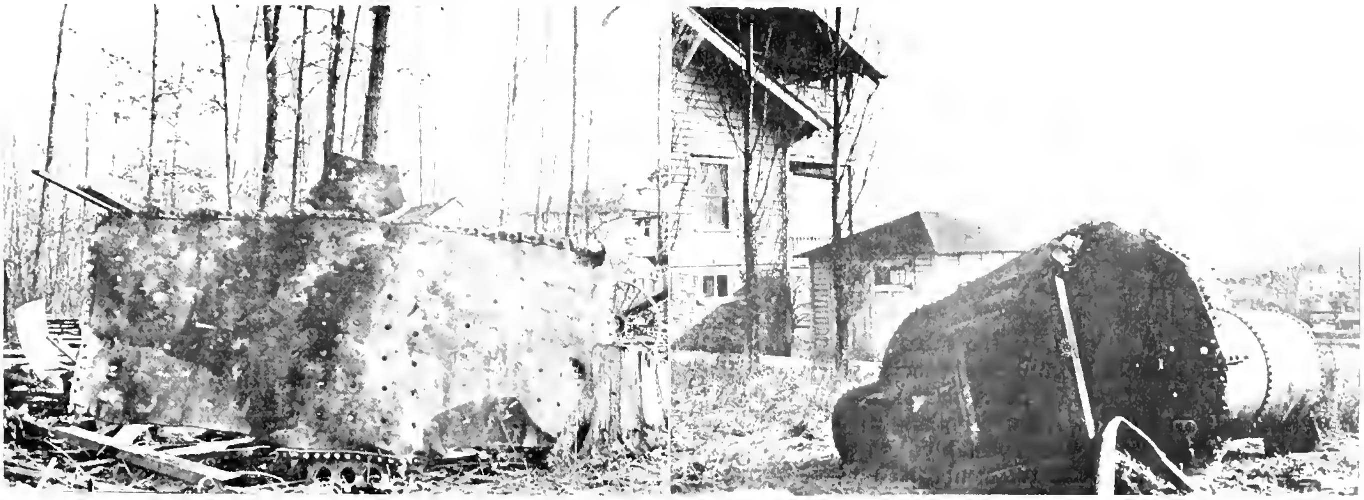


Fig. 2.—Crown Sheet of Boiler and Firebox and Barrel Near Scene of Disaster

location, and about 25 feet from a bungalow. Part of the tube sheet was found about 250 yards farther than the boiler itself and in a line of the same direction as that taken by the boiler. The crown sheet was found about 100 feet from the original location of the boiler and in a direction directly opposite from that taken by the boiler. The fusible plug was in the original position, but fusible metal was removed and a ⅜ inch bolt had been substituted, Fig. 3. The crown sheet shows evidence of excessive overheating, the sheet being very much burned. No evidence of rivet failure is indicated but the plates show a clean shear in every instance.

The explosion was undoubtedly caused from low water as evidenced by the condition of plates. This is substantiated by testimony from residents, who state that the engineer was attempting to feed water into the boiler at the time of the explosion, but boiler ruptured before completing his action. The engineer was instantly killed and the owner of the plant has since died of injuries received, while two other persons are in the hospital, seriously injured. There is no doubt that if the boiler had received periodical inspection by an authorized inspector this condition of the fusible plug would have been detected and ordered removed and a proper type plug substituted, which would have undoubtedly prevented this disaster with its consequent loss of life and property damage. I have also learned since the investigation that the "engineer" of this outfit was a teamster before taking charge of boiler.

Philadelphia, Pa. F. W. JAMES.

Relative Safety of Firetube and Watertube Boilers

In general, the watertube boiler is safer than the firetube boiler because of the fact that the former does not store so much water. The late Dr. Robert H. Thurston, Dean of Sibley College, Cornell University, figured that in a plain cylindrical boiler under 100 pounds steam pressure, enough energy is stored to throw the boiler to a height of over three and one-half miles in case of an explosion. This is because hot water contains so much energy and because there is so much water in cylindrical boilers. He said: "A cubic foot of heated water under a pressure of from 60 to 70 pounds per square inch has about the same energy as one pound of gunpowder." This is one of the reasons why the watertube boiler is so often given the preference to the firetube boiler.

Firetube boilers are generally large in diameter. The greater the diameter the greater must be the thickness of the metal to withstand the given pressure and consequently the greater the weight of steel necessary and the greater the cost. The watertube boiler again has the advantage in that the drums of watertube boilers seldom exceed 48 inches in diameter, hence the plate thickness is never excessive.

The tubes of the watertube boiler always come in contact with the most intense heat. However, since these tubes are comparatively small in diameter and of great strength they have a high factor of safety, much higher than the usual factor of safety of a firetube boiler, the thick shell of which is exposed to the most intense heat.

Also, in the watertube boiler there are no compressive stresses whatever. Pressures always act from within, both in the drums and in the tubes, consequently all metal is in tension. In the firetube boiler the tubes are in compression and are always liable to collapse, especially when they become thin or when made in large diameters.

While it is true that watertube boilers sometimes explode, such explosions are almost invariably less dangerous than firetube boiler explosions. Watertube boiler explosions seldom occur due to weak drums because the drums are well protected from intense heat. If there is any breaking or bursting at all it is usually a tube, and tube failures are seldom serious.

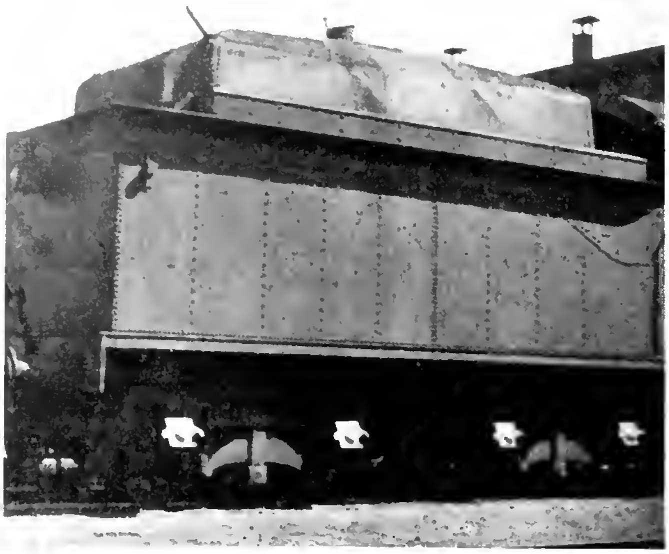
We would like to hear from our readers on the side of the firetube boiler.

Newark, N. J. N. G. NEAR.

Oil Tank Explosion on a South American Railroad

CARELESSNESS of any kind in the operation or maintenance of locomotives is sure to cause trouble. The following incident, which occurred on a South American railroad, illustrates this truth very aptly.

The attendant started to determine the amount of oil in the tank by means of a measuring rod with a naked flare



Oil Tank Failure Caused by Carelessness in Observing Precautions When Filling

lamp for light. The result was a bad explosion. The rod was kept in a loose guide in the top of the tank and, of course, the hot gases escaping around it became ignited the moment they came in contact with the light and followed through into the tank with the result shown.

The tank was torn from its seating, also from the strengthening brackets inside, top and bottom, and made useless for further service.

Colombia, C. A. W. T.

Condensed Rules for Inspecting Locomotive Boilers

(*Continued from page 62*)

there are any leaks the lagging should be removed and the trouble located.

A monthly inspection report should be filed with the district Interstate Commerce inspector and a copy of this report carried in the cab. An annual report must also be filed with the district inspector. A specification card and any changes on it are approved by the chief mechanical officer of the road and a copy filed with the chief inspector for each boiler. Any change in the boiler must be reported in thirty days to the chief inspector of the Board of Locomotive Inspection.

In the case of a boiler failure causing a serious injury or death of any person, the chief inspector at Washington should be informed by wire immediately.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

Vice-Chairman—D. S. Jacobus, New York.

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

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Executive Board—L. M. Stewart, G. B. I., Atlantic Coast Lines, Waycross, Ga., Chairman.

TRADE PUBLICATIONS

Tools for Boiler Making.—The J. Faessler Manufacturing Company, Moberly, Mo., has issued catalog No. 36 containing a complete descriptive list of all tools produced by this company. Details of roller flue and tube expanders, sectional beading expanders, flue cutters, patch bolt countersinking tools, etc., are contained in the catalog, in each case illustrations, tables of sizes and price lists being included. The company also maintains a department for designing tools for special requirements and difficult tube installations.

Oil Burners.—F. J. Ryan & Company, Philadelphia, Pa., has just issued bulletin 1B entitled "Mircs Oil Burners," containing a large amount of information of value to industrial users of oil-burning equipment. Essential factors in the efficient burning of fuel oil are pointed out; also the effect of relative air and oil pressures. Two sets of curves are illustrated from which the correct size of burner and necessary amounts of air needed for correct combustion can be determined. Details regarding the construction and operation of the Mircs burner are also included.

Pipe Products.—The products of the Whitlock Coil Pipe Company, Hartford, Conn., consisting of apparatus formed from pipe and tubing, or parts so formed, are described in a conveniently referenced pamphlet issued by this company. The products are divided into four classes—bent and welded piping for high pressure steam and fluids, coils of pipe and tubing which are made continuous by welding or brazing together the required number of pieces, welded receivers for storing fluids under high pressure and tubular heat exchanging devices.

Feed Water Treatment.—The scientific handling of serious water problems confronting both railroad and industrial users of steam boilers is the subject of a brief but forceful little booklet recently issued by the Dearborn Chemical Company, Chicago. This booklet shows (1) the complete mineral analysis; (2) study of plant equipment and operating conditions; (3) expert advice and assistance from the standpoint of practical power production engineering; (4) followed up with laboratory control after treatment is installed.

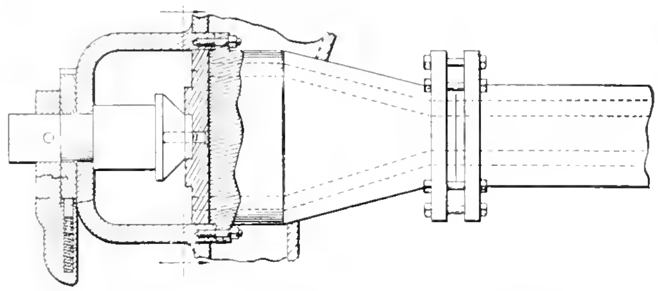
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,443,878. FLUE BLOWER. ROBERT E. JACKSON AND EDWIN M. JENKINS, OF PRINCETON, WEST VIRGINIA.

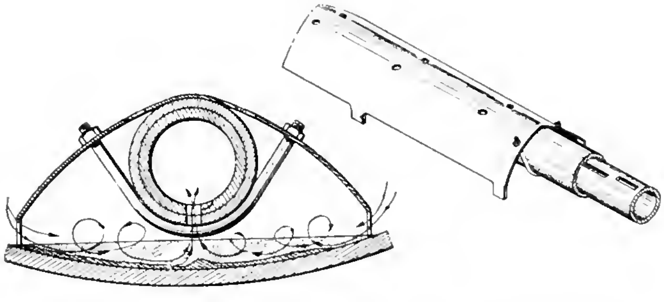
Claim 1. A flue blower adapted to be arranged transversely of a boiler in alinement with a row of flues, and being provided with a plurality of



passages corresponding in number to the number of flues, means for connecting said passages to the ends of the flues, a pipe connected to a source of compressed fluid, and means for connecting any one of said passages to said pipe. Six claims.

1,445,591. BOILER CLEAN-OUT DEVICE. MIKE HUFFMAN, OF DES MOINES, IOWA.

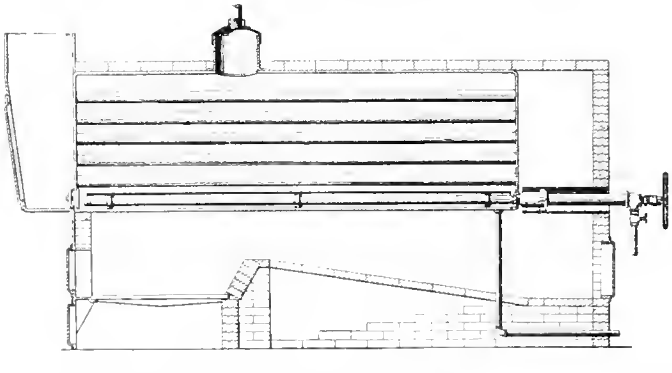
Claim.—The combination with a boiler clean-out device of the class described, of a deflector plate secured to the boiler clean-out device having



its top inclined downwardly and outwardly toward the bottom of the boiler, and its edges spaced from the bottom of the boiler, and circulating openings formed in said plate, and supporting legs at the edges of the plate to engage and rest upon the bottom of the boiler.

1,445,592. STEAM BOILER CLEAN OUT DEVICE. MIKE HUFFMAN, OF DES MOINES, IOWA.

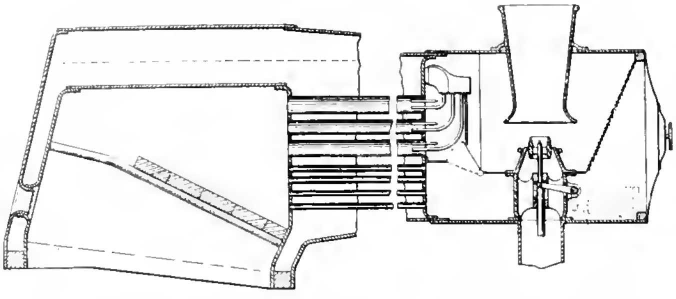
Claim 1.—In a device of the class described, in combination with a steam boiler of a supporting and coupling device designed to be permanently fixed in the rear wall of a boiler and provided at its forward end on the interior



of the boiler with projecting lugs, two pipes, one within the other designed to be inserted in the bottom of the boiler and being provided with openings that may be brought into alinement with each other, one of said pipes being provided with notches to receive said lugs and the other of said pipes being capable of rotation relative to the first, a pipe connected to the supporting and coupling device at the rear end, and means extending through the said rod and connected to the rotatable one of said pipes for holding said rotatable pipe rearwardly, and for providing means whereby the said rotatable pipe may be turned, for the purposes stated. Three claims.

1,437,719. MEANS FOR CONTROLLING THE OPERATION OF STEAM BOILERS. VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, NEW YORK, AND CHARLES H. SMOOT, OF SOUTH ORANGE, NEW JERSEY; SAID SMOOT ASSIGNOR TO RATEAU BATTU SMOOT ENGINEERING CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

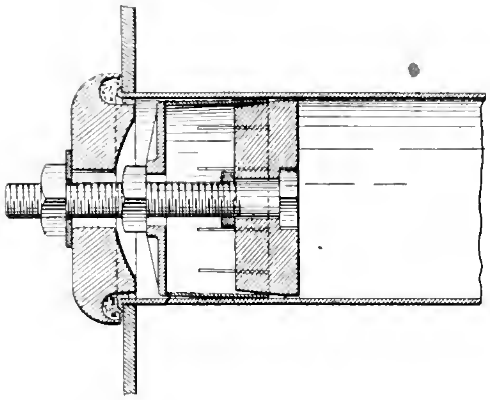
Claim 1.—In combination with a locomotive having a variable exhaust nozzle, pressure responsive means operatively connected to the movable ele-



ment of the exhaust nozzle and to different sources of pressure in the locomotive to thereby automatically actuate the movable element of the exhaust nozzle and vary the emission area of the nozzle orifice in direct proportion to variations in pressure at the several pressure sources. Nine claims.

1,444,351. BOILER TUBE STOPPER. LETTERIO MARTINO, OF EVERETT, MASSACHUSETTS.

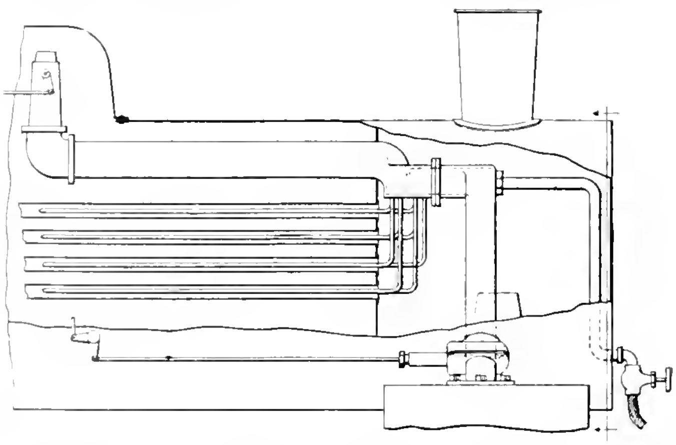
Claim 1.—In a device of the kind described, a plug for a tube comprising a wedge-piece, a slotted sleeve, adapted to engage the wedge surface of said



wedge-piece, means for adjusting said wedge-piece and said sleeve with relation to each other comprising a plate adapted to engage one end of said sleeve, a bolt, and a nut on said bolt adapted to engage said plate within the tube and force said sleeve onto said wedge-piece. Two claims.

1,443,970. SUPERHEAT LOCOMOTIVE. HARRY M. WILLIAMS, OF LITTLE ROCK, ARKANSAS, AND JOHN W. DEAN, DECEASED, LATE OF LITTLE ROCK, ARKANSAS, BY RUTH L. DEAN, ADMINISTRATRIX.

Claim.—A locomotive, including the boiler, smoke box and cylinder steam chests, in combination with a superheater, a steam supply pipe connecting said boiler and said superheater, a main throttle therein, steam pipes con-



necting said superheater and said steam chests, auxiliary throttles arranged in said pipes, a cross-connection communicating with each of said steam chests, a supply pipe for said cross-connection communicating with one of said superheat steam pipes above the throttle therein, a valve in the last said pipe, a steam pipe coupling for a burner, and a pipe for supplying superheated steam thereto, said pipe being connected to the opposite superheat steam pipe from that to which the cross-connection supply pipe is connected, and above the throttle therein substantially as described.

The Boiler Maker

APRIL, 1923

Fig. 1.—Section of Tank Shop Devoted to Welding

Fabricating Storage Tanks by Oxy-Acetylene Welding

The various processes of autogenous welding have become widely adopted in the manufacture of unfired pressure vessels and storage tanks. The following article deals with the methods employed by one producer of gasoline storage tanks to speed up the output and increase the economy of operation of his plant. Many boiler manufacturing companies during the past three years have gone extensively into the production of plate and tank work and the practices outlined here may suggest ways and means of boosting production as well as the proper procedure for the men in the shops to follow in the use of oxy-acetylene welding.

THE advantages of oxy-acetylene welding for production are no less great than for reclamation and repair. Evidence of this is presented by one of the country's foremost manufacturers of oil and gasoline storage systems who fabricates tanks of various descriptions entirely by oxy-acetylene welding.

Production Methods

There are several dominant factors in the production of light sheet metal products of this type, including the welding shop layout, preparation of the sheets for welding, welding practices, handling of material and testing and finishing. The proper attention to these factors determines to a large degree the quality and cost of the welded pieces.

The conduct of the welding shop and the production methods used at this manufacturer's plant are the result of years of experience and have proven to be efficient and economical. All material is prepared for welding in the metal forming department. As the manufacturer has numerous other lines of metal products besides the storage systems the equipment of the forming department serves with equal advantages the other shops of the plant.

Fabricating Underground Storage Tanks

Galvanized iron sheets are rolled along the short dimension for large underground storage tanks, three such sheets forming the sides of a tank. When the sheets are rolled this way rather than into cylinders, as is often done, tanks are built without circumferential seams, a style of tank construction preferred by this manufacturer.

The end sheets for this type of tanks are dished and flanged and holes for pipe connections are punched in the side and end sheets by the forming department. For lubricating oil storage tanks 3/16-inch steel sheets are bent into a "U" shape on power driven presses. The round holes for pipe connections are then punched, and the large square hole is cut with an oxy-acetylene cutting blowpipe.

Rectangular Tank Construction

Steel sheets for other types of rectangular tanks are also formed by bending once or twice, depending on the type and purpose of the tank. For small types of round storage tanks galvanized iron sheets are rolled into cylinders so that only one longitudinal seam is necessary to join the sides. Neither the steel nor galvanized iron sheets are beveled or otherwise

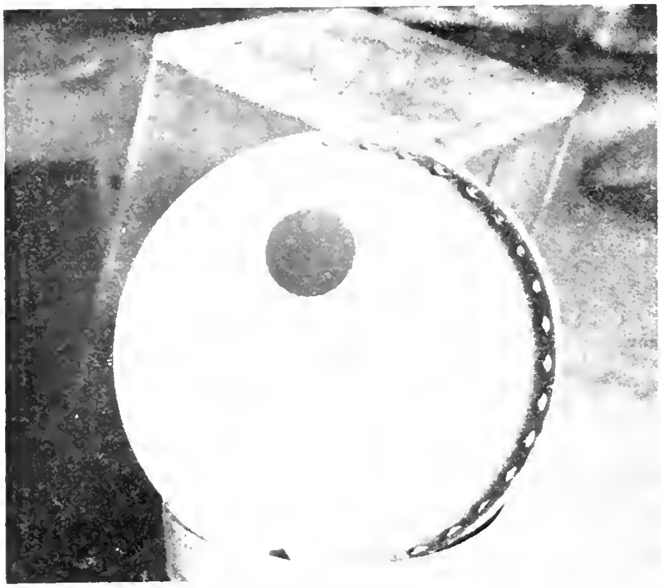


Fig. 2.—Dished Tank Head Ready for Assembly

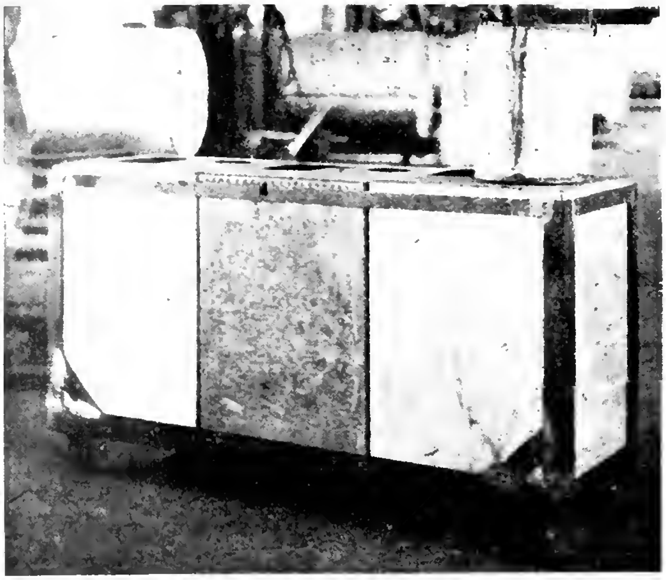


Fig. 3.—Oil Storage Tanks Ready for Welding

prepared for welding, except to be formed. Great care, however, is taken by the forming department because unless the sheets are prepared exactly in accordance with specifications, the welders are slowed up and the quality of their work is lowered by the necessity of working on poorly prepared or misformed metal.

Layout of Welding Shop

The welding shop is located in the same building as the forming and finishing departments. The welding stations are in a row and in line along a crane way, between columns on which acetylene pipe line connections are hung and to which oxygen cylinders are attached. Circulating space is maintained on each side of the line of stations for the delivery of formed material from one side and so the welded pieces can be moved out from the other side.

Welding Equipment

A 500-pound carbide capacity Oxweld low pressure Duplex generator furnishes the supply of acetylene gas for 18 welding stations, the average number operated at one time. Oxweld low pressure welding and cutting apparatus and Linde oxygen are used. To facilitate the handling of round storage tanks, several stations are equipped with racks consisting of a track fixed to the floor on which a car travels parallel to the position in which the welder works. The cars are equipped with rollers, so that an operator can revolve a tank in either direction or move it horizontally through its entire length, which makes it possible for him to weld at any point on the tank without changing his position. With this system every motion is productive.

An overhead crane is used to convey the material to the welding stations and to move the welded work out to the testing and finishing departments. It is the practice to have the welding shop work on only one type of tank at a time. Each operator is trained to weld with equally good results on the different types of tanks, which enables the entire force of the welding shop to be concentrated on one product until the entire production has been completed. This system con-

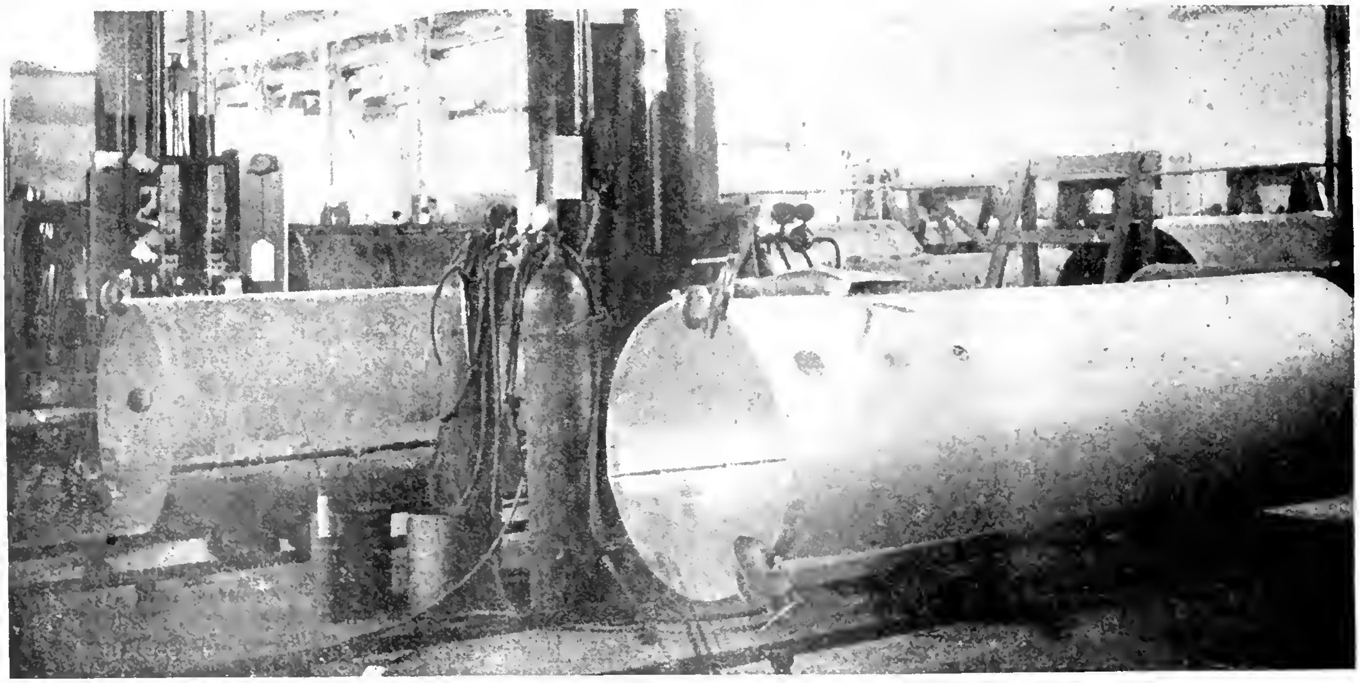


Fig. 4.—Sheet Metal Tanks in Process of Fabrication

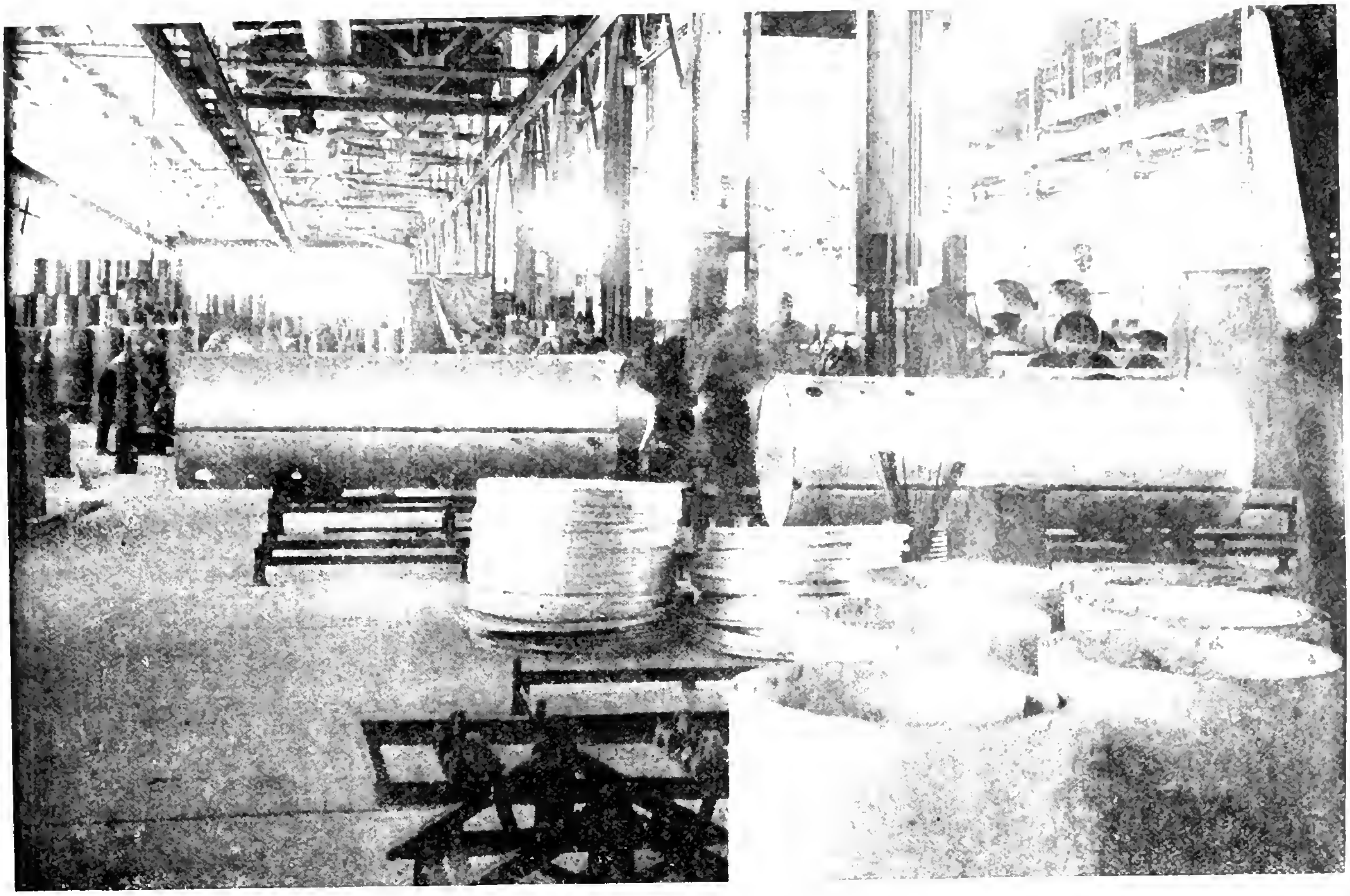


Fig. 5.—Tank Shells After Welding, Ready for Assembly of Heads

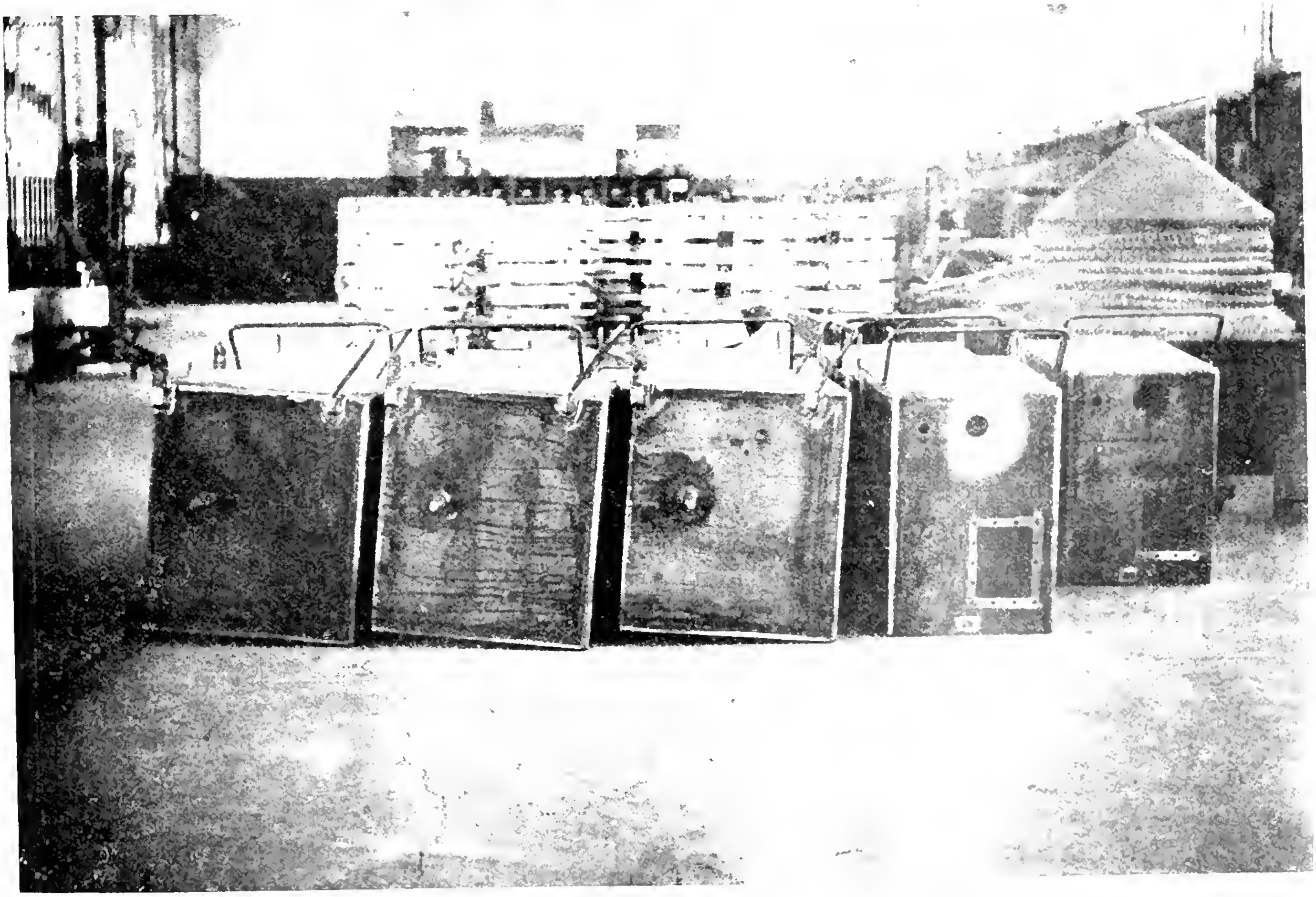


Fig. 6.—Lubricating Oil Storage Tanks of An All-Welded

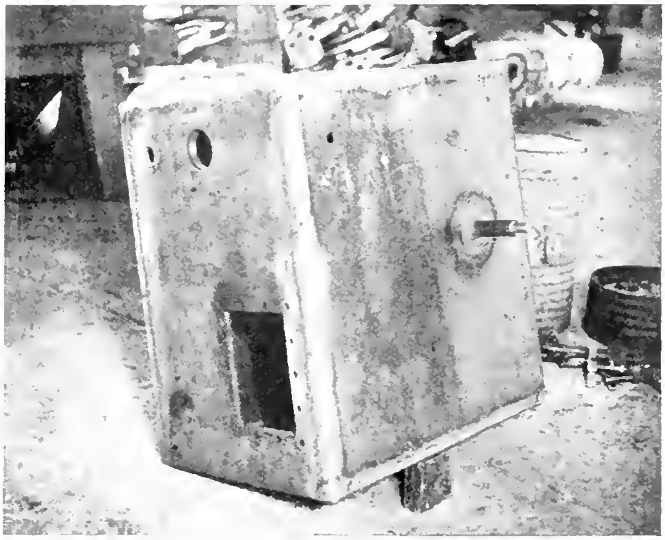


Fig. 7.—All Seams on This Tank Are Butt Welded

tributes toward better welding and quicker handling and inspection with a consequent saving in production cost.

Galvanized iron storage tanks of various capacities form the principal product of the welding shop. Fabrication of the larger sizes proceeds as follows:

Three rolled sheets are clamped to a form and are tack welded into place. Then the form is removed, but the clamps are left in place until the welding is completed, to aid in counteracting the tendency of the sheet to expand while the welding is in progress. The side seams are then welded, a drawn iron welding rod being used as a filler. When the sides are completed the tank ends which have been flanged are welded to the side sheets and then the pipe connections or nipples are welded into the holes that have been punched. One operator does all the welding required on a tank, so it is only necessary to handle a unit twice—the prepared material into the welding, and the fabricated tank out to the testing and finishing department.

The galvanized iron tanks shown in Figs. 4 and 5 are for gasoline. They are built of 12-gage sheets, are about 10 feet long, 5 feet in diameter and have a capacity of 10 barrels. This type and size of tank contains nearly 50 linear feet of welding.

The mobile oil storage tanks like the type illustrated in Figs. 6 and 7 are made of 2 "U" shaped sheets fitted together to form six sides. The 8 edge seams are butt welded. These tanks are built of 3/16-inch steel sheets, are about 25 inches long, 27 inches deep and 18 inches wide. They are a representative all-welded product, as the axles are welded to the sides, inside and out, and the handles, lugs, fittings, collars and brackets are welded to the tank body. All welded carriers for batteries of rectangular galvanized iron tanks are built of 2-inch angle iron. Tanks used in this are formed of galvanized iron sheets bent four times with a welded side seam and bottom. Several small sizes of round oil storage tanks are built of 16-gage galvanized iron sheets rolled into cylinders. These also have a welded side seam and bottom. Tanks of this type are for use in filling stations and garages, for the storage of small quantities of oil.

The principal requisite of a storage tank is, of course, permanent tightness. The tanks are, therefore, carefully tested, as an important part of the production. This is carried on as a separate step after the welding is completed and before the tanks are painted with waterproof paint or otherwise finished. Testing is done with compressed air or water. All openings in the tank are closed except the one through which about five pounds of pressure is applied. Then the seams are gone over with soap suds and thoroughly cleaned before shipment. The workmanship in this plant, however, is of such a high order and the welding is so closely supervised that leaks very rarely occur. By following closely recognized good welding methods and practices, such as penetrating the full depth of the steam, building up joints where additional strength is required and using only the best materials, a high standard of work is easily maintained.

In all the years that this manufacturer has used the oxy-acetylene process he has never received a complaint of a welded tank leaking, either at the welded joint or in the base metal adjacent to the weld. Although other joining processes have been tried out in this plant, actual tests have demonstrated that oxy-acetylene welding alone consistently produced leak-proof joints. The flexibility and economy of the process have further made it possible for the manufacturer to produce better tanks at less cost than it was possible to build by the old methods formerly employed.

Fig. 8.—Finished Drums Ready for Shipment

Types of Flue Expanders Used in British Shops

Roller Type Expanders Have Replaced Sectional Tools for Locomotive Boiler Flue Work

By A. Wrench

In the following article, the writer (who has for several years been in charge of a number of boiler makers using tube expanders) endeavors to enumerate several types of tube expanders used in England, for locomotive boilers. Unlike the practice in America, the roller type of tube expander is almost exclusively used in England. Many years ago, the sectional drift or expander was used, but this was rather a crude tool, as will be seen by the sketch, Fig. 1. The four sections were not held by a spring, but had to be inserted in the tube in sections or held round the drift by the operator. The tubes used at that time were principally copper and brass in copper tube plates, and were not beaded but flared and ferruled.

The sectional expander shown in Fig. 2 was an improvement on that previously mentioned and good results were obtained from prossering. This expander consists of three sections of cast steel and a tapered circular drift, the sections being held together by rubber bands. The cap of this expander is designed to pass over the tube ends and rest against the tube plate. This was a much better arrangement than the solid cap of the expander shown in Fig. 1.

It was some considerable time after steel tubes were generally adopted in this country that the roller expander came into use. The general type of this expander is shown in Fig. 5.

Variations in Design

All of these expanders for small tubes have three rollers but vary somewhat in design. The one illustrated consists of tapered mandril, roller box and three rollers. The mandril is fitted with a long nut, with which to force out the mandril by turning against the box. The roller box is fitted with a cap which rests against the tube plate, and which is capable of being adjusted by means of a set screw. The rolls are tapered the same as the mandril, with the taper reversed when in position. The expanding is done by driving the mandril with a wooden mallet and turning with a rachet. The expander is quite successful in use and is supplied in sizes from 1¼ inch to 2⅜ inch, advancing in ⅛ inches. It is rather expensive and its weak point is the screws at the end of the roller box, which are continually breaking.

Figs. 3 and 4 show the type of expander and rotator used

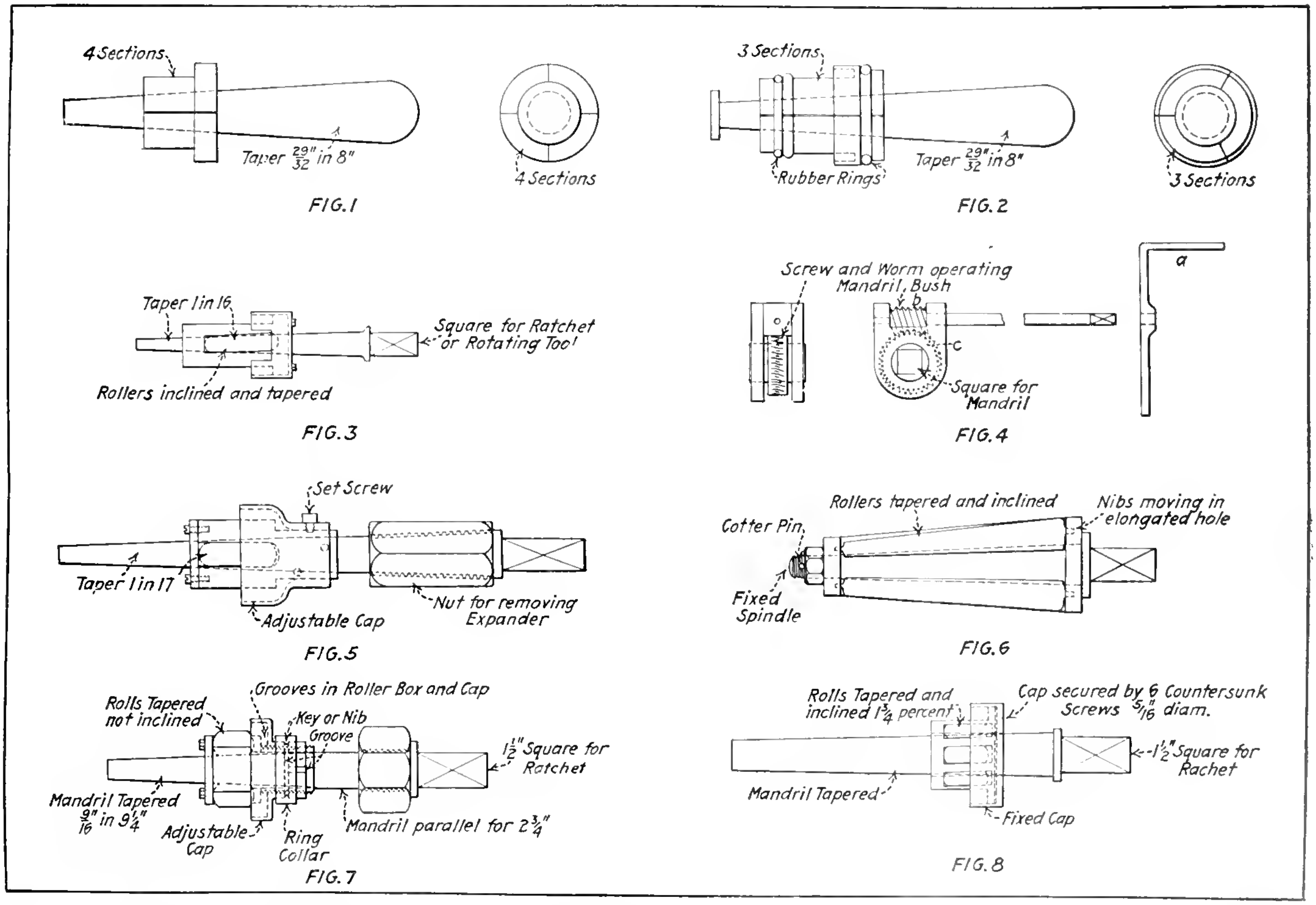


Fig. 1.—Sectional Drift Expander. Fig. 2.—Sectional Expander Prosser. Fig. 3.—Three Roller Expander for Superheater Tubes. Fig. 4.—Tool for Rotating Expander in Superheater Header. Fig. 5.—General Service Tube Expander. Fig 6.—Three Roller Expander for Tapered Holes. Fig. 7.—Three Roller Superheater Expander. Fig. 8.—Six Roller Expander for Large Flues

when working in a confined space, such as the steam header of a superheater. In this expander, the rolls are inclined slightly, to enable them to pull tight, without the use of a mallet, and the cap is secured by screws at the back end of the tool. The method of rotating is seen from the sketch, Fig. 4, the handle (a), turning worm (b), which operates the bush (c), containing the square for the mandril.

The expander shown in Fig. 6 is used for tapered holes, and will expand tubes of various sizes. The rollers are tapered and inclined and are fixed in the roller box by means of nibs at each end, which are fitted in elongated holes.

The inclination of the rolls enables the expander to pull tightly into the tube without hammering and, as the expanding proceeds, the expander passes further into the tube. The rollers of this expander sometimes break owing to their length and the inclination. It is self-contained and efficient, but should only be used on tube plates which have tapered holes.

When large superheater flues were first fitted, the design of the roller expander used for small tubes was followed. Several alterations were necessary, but the design in general was the same.

A superheater flue expander of the three roller type is shown in Fig. 7. The cap of this expander is made in two pieces and is adjustable by means of a number of "V" grooves cut in both halves of the cap, and also on the roller box. The cap is fitted with a ring collar, which has a small stud fitted in the center. This stud passes down a slot in the cap and engages in a circumferential groove in the two halves of the cap. The cap is adjusted by removing the ring collar and moving the two parts of the cap either backwards or forwards one, two, or more grooves. It should be understood that the grooves are not cut spirally, as a thread, but each one cut separately. This enables the cap to remain stationary against the tube sheet, while the roller box is turning. This prevents the cap from rubbing against the copper tube-sheet round the tube.

The original size of superheater flues is 4 inches, but after being in service for a considerable time, the holes get much bigger. When reamed out to 5 1/8 inches the sheet is near the scrapping point. Liners are fitted to tube holes exceeding 4 3/4 inches. Owing to this variation in size, it is necessary to employ two sizes of flue expanders, 4 inches and 4 1/2 inches, and there are usually two sizes of rollers to fit each box. The larger rollers can only be used when the holes in the roller box have become worn. A large size is also made for the smokebox end, which is usually 5 1/4 inches in diameter. The large sizes permit the use of the same size rolls as the small ones, the spindle and roller box being made bigger. The large nut on the end of the mandril of the superheater flue expanders is not of much use as frequently the distance between the nut and the roller box exceeds the thickness of the nut. The usual practice is to drive out the mandril by hammer blows on the nut.

The six roller expander, Fig. 8, is now being extensively used for large flues. This expander was discussed in an article by the writer, which was published in the *Railway Engineer* September, 1921, and reprinted in The Boiler Maker February, 1922. It is much cheaper to construct than the type shown in Fig. 7. It automatically tightens up on the mandril being turned, owing to the slight inclination on the rollers and is removed by turning the mandril in the opposite direction. It is important that the inclination on the rollers is not too great, or the rollers will become immovable before the flue is properly expanded. On the other hand, if the inclination is too small the time taken to expand the flue is too great. Differing from some expanders in use, the one shown on the sketch has a cap hollowed to fit over the tube end onto the flue sheet, this cap being fixed with six set screws through the cap into the box. This enables all tubes to be expanded through the same length. This is obviously a disadvantage where tube-sheets of various thicknesses are used, but in England most tube-plates are 1 inch thick, which allows the use of a fixed cap instead of an adjustable one. The rollers used are 15/16 inch diameter at the small end, against 1 5/8 inch diameter in the 3 roller type. This size of roller is used for the three sizes of expander in use, only the roller box and mandril being increased in size.

It has been found advantageous to grind the mandril in preference to turning, as the smooth surface thus obtained enables the expander to be withdrawn more easily.

In America, the sectional expander is used extensively, but this type would not be very suitable for terminal use where copper tube sheets are used, as frequently the flue holes are found to be in bad shape.

The three roller expander has been found to be very suitable for oval holes, as the mandril will bear on the rollers as they move out of the true circle, by the mandril moving eccentrically in the box.

The six roller expander allows the two rolls passing over the longer diameter to ride loose, the other four bearing on the tube and keeping the mandril central.

It has been stated that the three roller expander causes bad shaped holes, but this is not so. Frequently when superheat flues are reported leaking in a running shed, six or seven will be found leaking out of twenty-four.

The expanding of these by any type of expander will disturb the plate, and tend to distort adjacent holes. The writer's experience is that those holes in the top corners of the tube-plate are found to be most badly out of shape and in most cases these holes have only been expanded when fitted new. Upward expansion of the tube-plate, and compression where girder stays are used, account for misshapen flue holes in many cases.

The superheater flue expanders illustrated do their work well, but it is not practicable to dispense with the three roller expander entirely, as this is most suitable for work in railway terminals. The six roller expander is suitable for workshop use where round holes have only to be dealt with.

Program of Annual Meeting of American Boiler Manufacturers' Association

The program for the American Boiler Manufacturers' Association meeting to be held June 4, 5 and 6 at The Homestead, Hot Springs, Virginia, is given below:

June 4—Morning—President's address. Address by H. D. Sayre, National Metal Trades Association. Appointment of Auditing and Nominating Committees. Report of secretary and treasurer. Report of Entertainment Committee.

Afternoon—Golf tournament, etc.

Evening—Round table discussion "Practices and Conditions Existing in the Industry." (A series of questions concerning practices and conditions in the industry is being prepared and will be forwarded to all members several weeks in advance of the meeting in order that members may study them over, prepare for discussion and, further, thus be enabled to make suggestions as to other matters which can properly be brought up for discussion at this session.)

June 5—Morning—Reports of standing and special committees including, among other matters, report and recommendations of Commercial Committee on Standardized Ratings of Steam Boilers; the Joint Stoker Committee which will report on simplified methods of determining stack sizes, demonstrating how tables and charts are to be used; report of Committee on Contact with Smoke Prevention Association, concerning setting heights, HRT boilers, etc.

Afternoon—Golf tournament.

Evening—Informal banquet.

June 6—Morning—The Cost Accounting Committee report. Reports of Auditing Committee and Nominating Committee. Election and installation of officers. Miscellaneous business. New business. Adjournment.

A Great Boiler Explosion in Old Austria

Battery of Four Boilers Completely Destroyed by Explosion Caused by Low Water and Overheating

By John Jaschke

ONE of the greatest boiler explosions ever occurring on the European continent happened on December 21, 1914 at Brüx in Bohemia—now Czechoslovakia. Since July 25, 1887, when the 22 boilers of the Friedrichshütte exploded, no explosion so disastrous as this has happened.

There was a battery of four combined cylindrical boilers

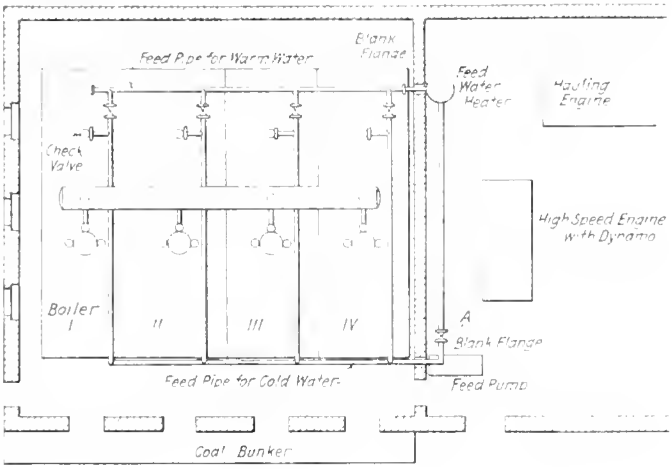


Fig. 1.—Boiler Plant of Brüx Colliery

in the boiler house of the plant Prinz Eugen, a colliery at Brüx, as shown in Fig. 1. The design of such a boiler is given in Fig. 2. Each boiler consists of three cylindrical drums, an upper drum 59 inches in diameter, 31 feet in length, two lower drums each 31½ inches in diameter, 28 feet in length, connected with double flange nozzles 23⅝ inches in diameter. On the upper drum there is a dome 1½ inches in diameter, 31½ inches in length.

Details of Capacity

Across the four boilers there was a steam receiver. All the boilers were of 75 horsepower rating which worked at a pressure of 114 pounds per square inch, at 100 percent load. The longitudinal seams of the upper drum were double riveted, all other seams were single riveted. All seams were lap joints.

The boilers were built in 1899 by Bolrano, Tedesco and Company in Schlan. All boilers since their erection had been repaired and partly renewed.

Three of the four boilers were working and the fourth was in reserve. On the day of the explosion, boiler No. 1 was cold and blown out. Each boiler was required to work four weeks under pressure, after that time it was cleaned, both inside and outside. The feed water did not form any scale but only mud. The steam has to do work in generators and colliery engines, hauling engines, etc. The steam was partly used for heating purposes.

Boiler Feeding Equipment

For feeding the boilers an injector and a steam pump were installed. There were two feeding devices, one for cold and one for heated water. Each could be worked by itself. For blowing out, each lower drum had an elbow; the right being closed by a cock, the left by a blank flange. The boiler could only be emptied, when it was cold. The blank flange was used because it could be kept tight easier than a cock.

On the day of the explosion the boilers were operated by two men, an experienced fireman and his apprentice, who was to be examined in a short time. The apprentice went out at 5 o'clock in the afternoon and the fireman remained alone.

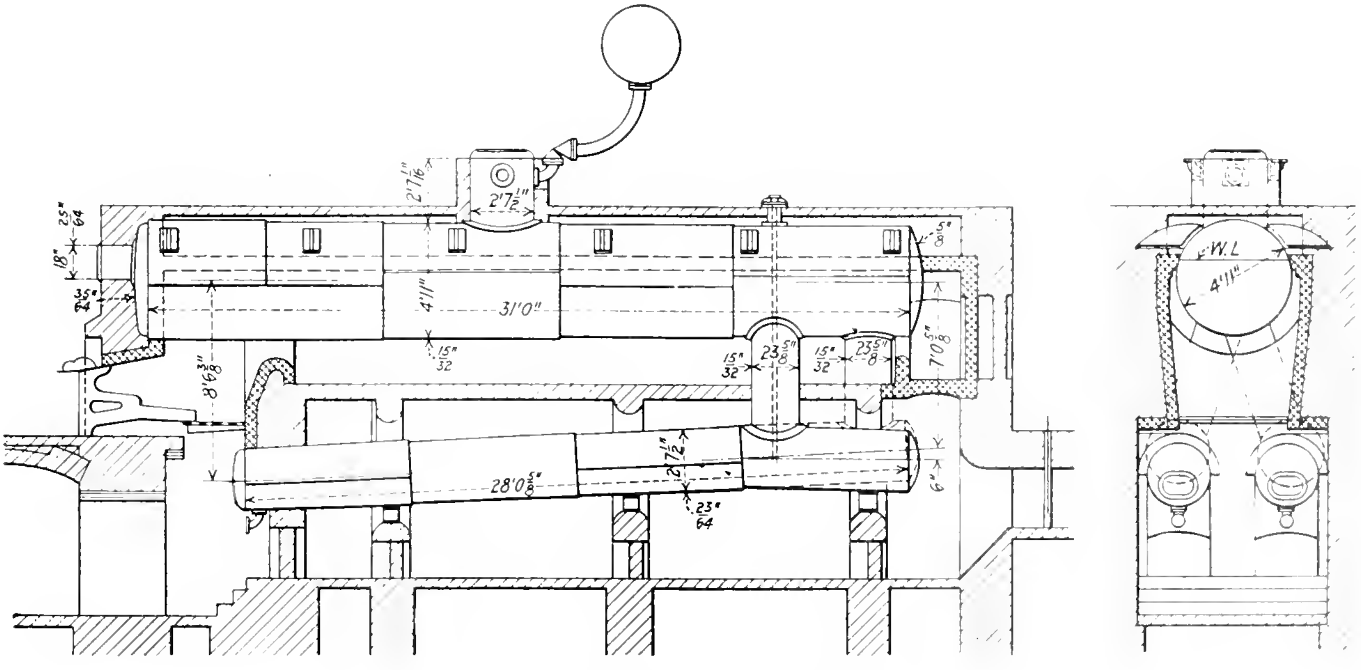


Fig. 2.—Design of Boilers Which Failed

The explosion occurred on December 21, 1914, at a quarter past five in the afternoon. The boiler house and the engine house were completely destroyed. Ruins and parts of the roof were blown for some distance onto the right of way of a railroad in the neighborhood. By luck no men were working. Fortunately no one was at the loading place and no train passing the plant at the time. The fireman was killed, another man badly injured who died the following night. The body of the fireman was found in the stokehold standing upright covered by ruins.

The location of the parts of the boilers is shown in Fig. 3. The first and second courses of the upper drum from boiler No. 2 were blown a distance of about 200 feet. Three boilers standing under pressure were exploded, the fourth boiler being out of the line was turned over.

Boiler No. 2 exploded first, due to lack of water. The fireplate became overheated and burst. This plate was seen to be red hot a short time after the explosion. Two strips of 28 inches breadth, glowed, the space between being dark and covered with a layer of mud.

The upper drums of boilers Nos. 3 and 4 were pushed to the right and therefore the flanges of the nozzle broke and both boilers exploded. Boiler No. 1 was blown against the chimney and turned over, no crack in it being visible.

Boiler No. 1—No destruction.

Boiler No. 2—This boiler was blown into six pieces, i.e., three courses of the upper drum with the dome and the left

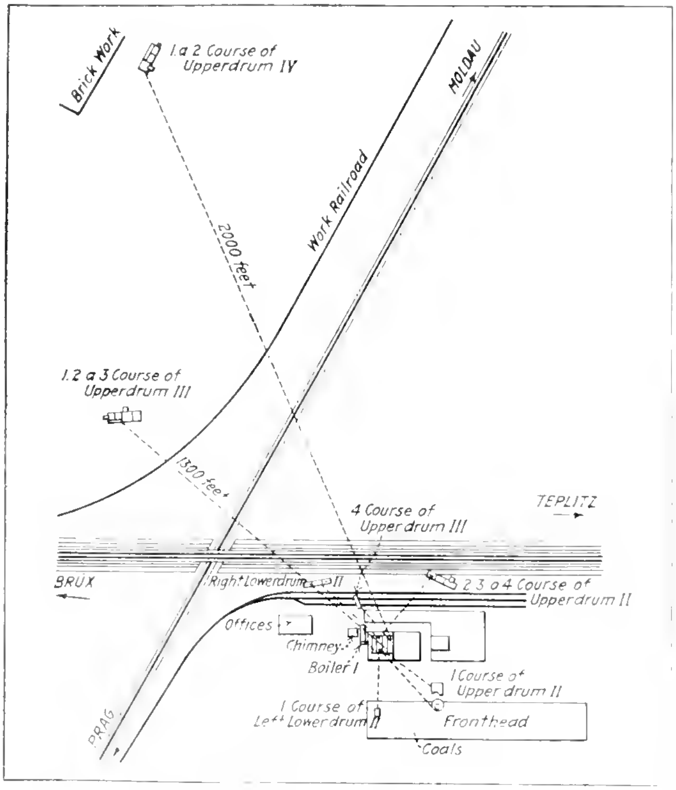


Fig. 3.—Location of Parts of Boilers After Explosion

connecting nozzle; the right lower drum; the greater part of the left lower drum; the first course of the upper drum; the dished fronthead; the last course of the left lower drum.

Boilers Nos. 3 and 4—Both boilers were blown into four parts; the two lower drums; upper drums divided into two parts.

The steam valve of the feed pump and the injector was found closed, therefore at the time of explosion they could not have been in operation. The pump and the injector were tested and both found in good order.

Two days before the explosion occurred, the feedwater heater became loose and the valve A was closed. But this valve was also loose and the feedwater was passed through the heater in the blowout pipe and therefore two blank sheets were inserted.

It was a habit of the fireman to keep all feeding valves

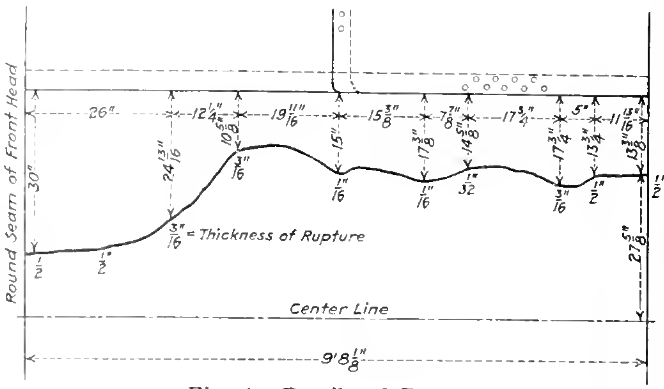


Fig. 4.—Details of Rupture

open and to regulate the water flow with valves in the stokehold. He did not notice that the water was low in boiler No. 2 and so did not regulate the valves. The boiler became empty and the fire plate began to glow and overheat. The fire plate burst for the length in the solid plate and not in the seam. The middle part of the rupture was as sharp as a knife for a length of about six feet, Fig. 4.

Boiler No. 2 exploded first. The fireplate cracked on the left hand side, so that the boiler was blown to the right. Only boilers Nos. 3 and 4 turned with the nozzles as centers. The nozzles cracked and both the boilers exploded. The steam from boiler No. 2 blew boiler No. 1 against the stack.

Stretching Boiler Tubes*

By W. Stevenson

Stretching of boiler tubes on repair work or new work under construction injures the tubes by the stretching of the metal and may endanger the lives of the boiler operators or of any persons who may be in the vicinity of the boilers in the event of the tubes rupturing. The stretching of the tubes is performed in the following manner:

A sufficient length is allowed at one end. The tube is then expanded in place, the expander removed and the tube flared and heated. A long pipe or bar is heated in a furnace and then placed into the tube. The tube expands to the point of the least resistance, and when sufficient length is secured, the heated bar is withdrawn from the tube and the opposite end is flared and expanded before the metal has any possible chance of shrinking to its original position.

Naturally, under these conditions the tube sags and a strain is brought upon the tube close to the head. Moreover, the sagging makes it difficult to clean out the tube properly.

These conditions can be avoided only in the boiler shop by laying out the boiler plate so as to allow sufficient length for a standard size tube. Furthermore, it is important that a strong back be applied to each head and the tube sheet properly leveled before any tubes are expanded. If the tube-sheet flange should be slightly out of proportion, the next longest tube should be cut to suit the required length.

If a boiler already in service has developed a bulge in the tube sheet or headers and if the standard size tube which the boiler was designed for does not come within the required length, a new tube of extra length should be ordered.

*From a recent issue of *Power*.

Can the Scotch Boiler Be Improved?*

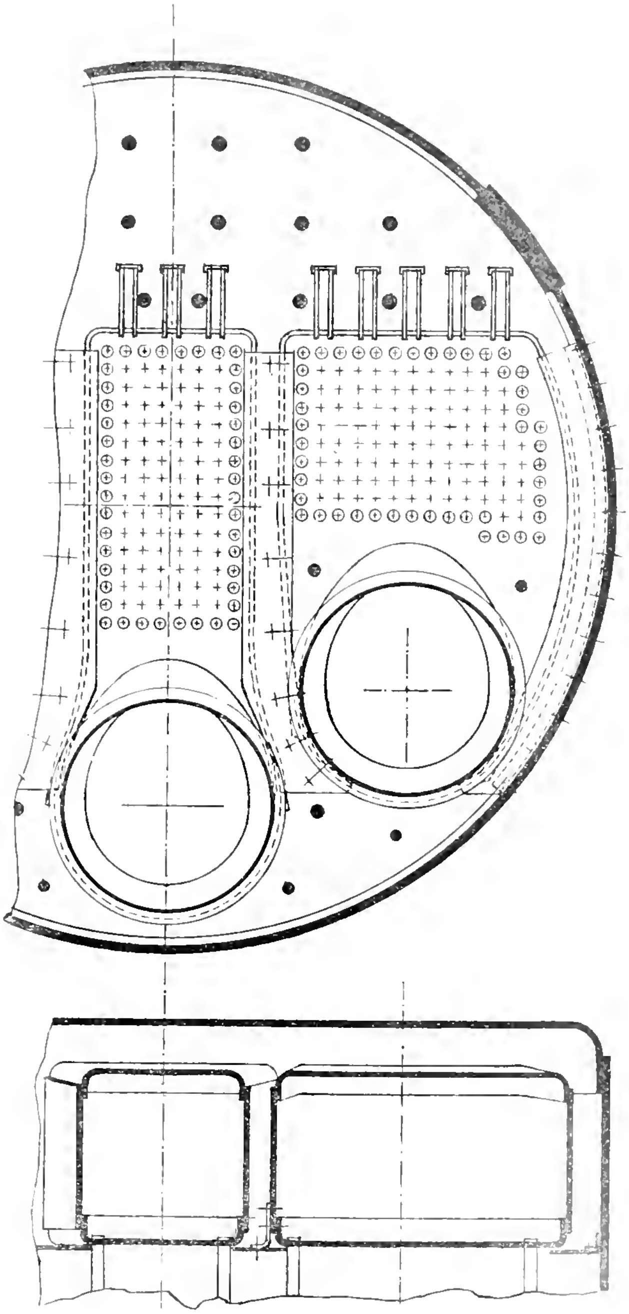
Details of Alterations Effected in the Scotch Boilers of a Large Steam Yacht with Beneficial Results

THE return tube marine boiler, generally known as the Scotch boiler, has had practically the same form for over forty years, and seems to have reached its final stage of development, but it is hoped to be able to show in this article that it can be improved in such a way as to increase its efficiency considerably.

There has always been a tendency to prime, due to irregularity in the circulation, and anything that will steady the circulation currents, or cause them to follow one direction only, will reduce this tendency to carry water over with the steam. Various forms of circulating devices have been fitted, outside the boiler itself, which take water from below the furnaces and return it to the boiler at a higher level, or from the front to the back, all of which, while minimizing the trouble, do not entirely remove it, and prove that there is room for improvement in the design of this class of boiler.

Now, the cause of any current in the water inside a boiler is due to a difference of temperature, the hotter water rising and the cooler falling, so that the water below the line of the grates is always much lower in temperature than that between and above the tubes. This difference of temperature often causes very severe strains, especially when getting up steam from cold, so that seams in the neighborhood of the bottom and back often need re-calking.

The hottest surfaces in the boiler are the furnace crowns and the back-plates of the back connections, so if no water can pass from the front to the back of the back connections, in a horizontal direction, from the level of the bottom of the furnaces to the level of the top row of tubes, a very rapid and energetic circulation is set up in a vertical direction between the sides and back of the back connections and the shell and back-end plates of the boiler, the only source of supply for this current being the water below and between the furnaces. It passes over the top of the back connections towards the front, passes downwards between the groups of tubes and between the outside vertical rows of tubes and the shell plates to supply the rising currents produced by the furnace crowns, the tubes and the back-plates of the back connections. This current is set up as soon as the fires are lighted, it is always in the same direction and is maintained as long as there is any fuel burning.

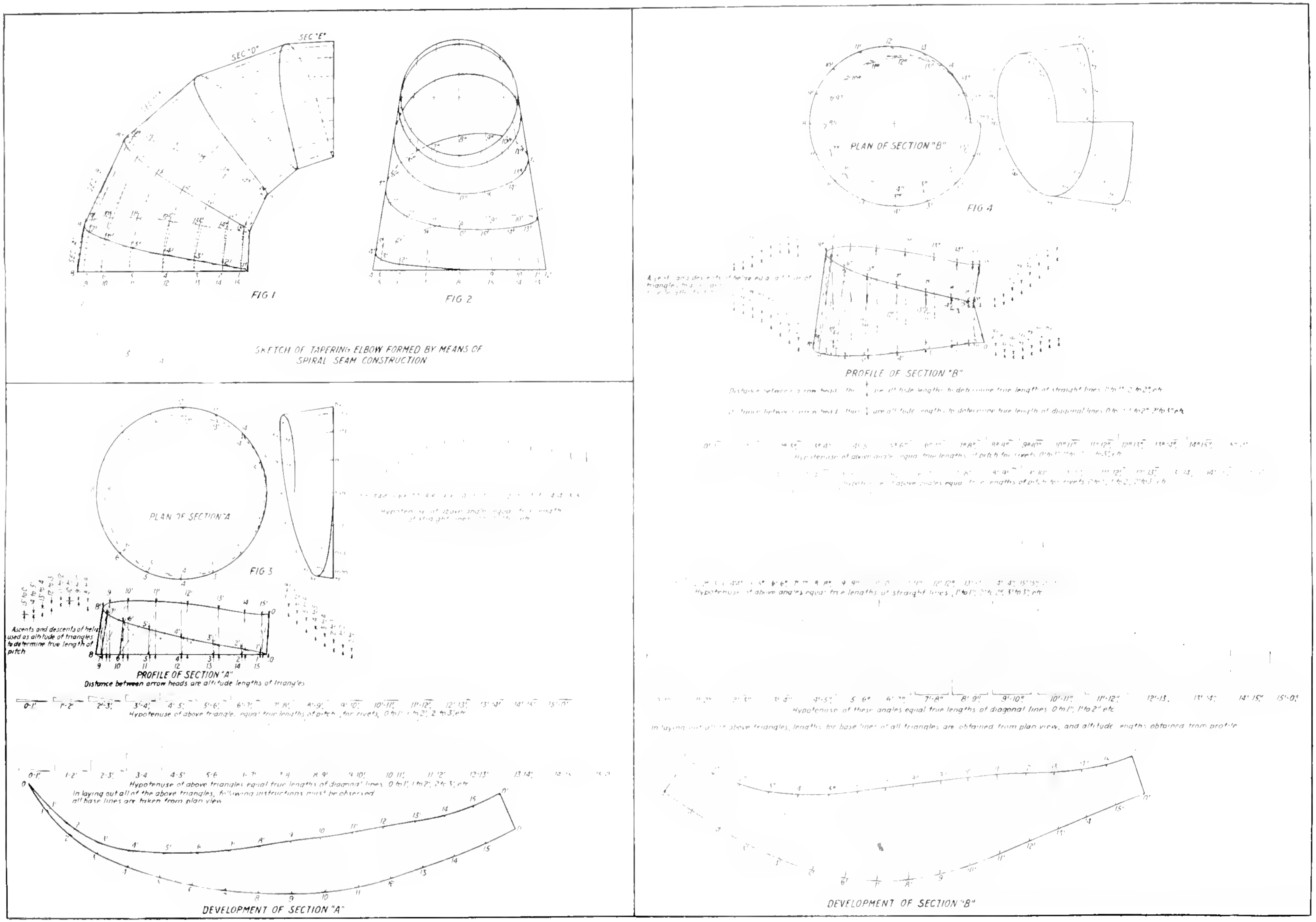


Scotch Boiler Fitted with Special Circulating Baffles

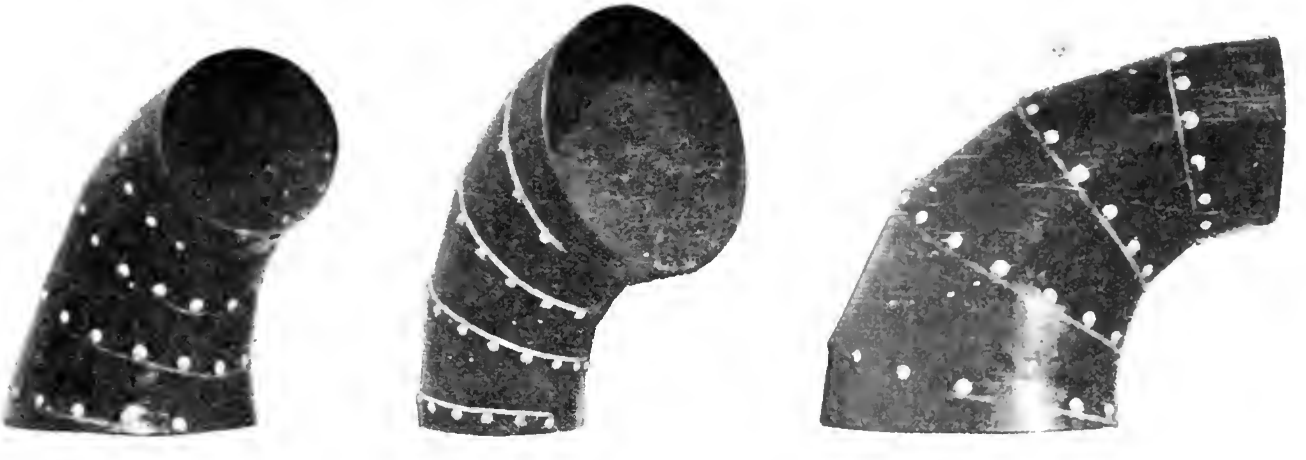
The necessary baffle plates can be secured, as shown in the accompanying drawing, by angle irons to the shell plates and rest against the front tube-plates of the outside back connections, as a watertight joint at this point is not a necessity. Between adjacent back connections the baffle plate is secured by means of stays riveted to the wrapper plate of one, and rests against the tube plates of both. The baffle plates cause no temperature strains whatever, and do not interfere with the scaling of the boiler. A large steam yacht, built at Wilmington, Del., had four boilers with two furnaces in each. One of these boilers was fitted with baffle plates, as described, but the other three were left without any. When in commission the following results were obtained:—When raising steam from cold the fires had to be lighted in the three boilers without the baffle plates one hour before the fires were lighted in the remaining boiler, in order that all four should show steam at the same time. When steaming at 10 knots, the boiler with the baffle plates could furnish all the steam the engines required, whereas two of the other boilers were necessary for the same service, one alone could not be made to supply steam enough; moreover, it primed so much that there was danger of wrecking the engines. The one boiler fitted with the baffle plates was never known to prime, not even in rough weather. When cruising, the yacht would often stay at a port for a week or more at a time, fires being raked out and the boilers allowed to go cold. When getting up steam again the boiler maker always had to do some re-calking to all three boilers not fitted with baffle plates, the other one never required anything doing

(*Continued on page* 114)

* From the January issue of The Marine Engineer and Naval Architect.



General Details of Tapering Elbow Built Up on a Spiral Development



Three Views of the Spiral Sheet Layout of a Transition Elbow

Development of a Spiral Seam Elbow

Details of the Layout of Patterns for a Tapering Elbow Built Up in a Helical Form

By C. A. Chincholl

WHENEVER the talk or gossip in a boiler shop drifts into the channels of laying out it generally snags on the problem of laying out, or developing the stretch-out of a one-piece helical or spiral seam, tapering elbow. This is exactly what happened in our shop during the noon hour of a day last winter while we were assembled about the flange fire. During the discussion, someone asked the writer if he thought he could lay out an elbow according to certain specifications. I informed them as I had never before attempted it, I would not say. But I did tell them the first opportunity that would present itself I would try to lay out and assemble the elbow under discussion. The elbow shown in the accompanying illustrations was the result of my efforts. The actual size is 12 inches in diameter at the large end tapering to 8 inches. The laying out was very satisfactory as in the assembling every rivet hole showed up fair as a die. It was constructed of number 12 gage sheet steel, in order that the thickness of the plate might receive its share of consideration in the development.

Thinking the readers of THE BOILER MAKER would be interested in the laying out of this form of elbow and perhaps prove of benefit to some, I have in the following lines with the aid of sketches, endeavored to outline a simple explanation so that it might also be used by the trade apprentices.

METHOD OF DEVELOPING THE PATTERN

In developing the pattern or layout of this elbow it is first necessary to locate the rivet line or seam as shown in Figs. 1 and 2. This is obtained in the same manner as the laying out of the helical or spiral on any cylinder. The lines necessary to lay out the helical seam on the elbow, will be found in the lower section of Fig. 1. They are self-explanatory so no detailed description will be given.

Particular attention must be paid to the prime marks of the different numbers, they are of paramount importance, and must in no instance be overlooked.

By referring to Fig. 1 you will notice it has been divided into five sections as *A*, *B*, *C*, *D* and *E*. This is only to simplify the laying out, as the pattern complete will be in one piece. Each revolution of metal is here taken as a section. Numbers 0 to 16 inclusive represent the bottom circumference of section *A*. Numbers 0 to 0′ inclusive represent the top rivet line of section *A* and also the bottom rivet line of section *B*. Numbers 0′ to 0″ inclusive represent the top rivet line of section *B* and the bottom rivet line of section *C* and so forth to section *E*.

STARTING THE LAYOUT

Beginning the layout with section *A*, sketch from Figs. 1 and 2, the section marked *A* and develop the plan of section *A* as in Fig. 3. In referring to Fig. 3 you will observe two dotted circular lines parallel to each other. This is where the thickness of plate is taken care of. If the elbow is to be made of number 12 gage plate, the inner circular line is set 3/32 inch from the outer line. If 1/4-inch plate is used, set the line 1/4 inch in from the outer line. After you have taken care of the thickness of plate in the above manner, the outer line is disregarded and the work done from the inner line. The next step is to draw diagonal lines on the plan and profile sketch as from 0 to 1′, 1 to 2′, 2 to 3′, etc. We next must obtain the true lengths of all the lines in the plan and the profile views, by use of the triangle. No true lengths need be ascertained for lines 0 to 1, 1 to 2, etc., as these are simply one-sixteenth part of the circumference of the largest diameter or base of the elbow.

In the plan view, 0′ to 1′, 1′ to 2′, etc., will not serve as the true pitch of rivets, so we must take the space each pitch ascends or descends in the profile view. Use this as the altitude of the triangle and the distance or space between 0′ to 1′, 1′ to 2′, etc., in the plan view as the base of the triangles. The hypotenuse will be the true pitch of the rivets.

ERECTING TRUE LENGTH TRIANGLES

In erecting the triangles the base lines are taken from the plan view and the altitude or heights of the triangles are obtained from the profile. After all the true lengths are found we are now ready to develop the pattern or layout for section *A*. Starting at 0, or the first one-sixteenth part of section *A*, we will disregard diagonal line 0 to 1′, and start the layout by drawing angle 0, 1′ and 1, taking the true lengths from the triangles previously prepared. We now are ready for the next space; set the dividers at the true length of 1′ to 2′ and with 1′ as center, describe an arc; set the dividers at the true length of the diagonal line 1 to 2′ and intersect the arc at 2′. Now set the dividers one-sixteenth of the circumference of the base, or 1 to 2, and draw the arc with 1 as center. Intersect this arc with the true length of the straight line 2′ to 2, using 2′ as center. This will complete one-eighth of the development of section *A*. Advance in this manner until straight line 0 to 0′ is reached; this is the first line in developing section *B* and completes the development of section *A*.

Developing the Second Section

We now start the development of section *B*, taking the true length of the rivet pitch 0′ to 1″ and with 0′ as a center describe an arc. Intersect this arc with the true length of the diagonal line 0 to 1″ using 0 as center and intersection at 1″. Use true length of rivet pitch 0 to 1′, describe arc using 0 as center. Intersect this arc with the true length of the straight line 1′ to 1″, using 1″ as center. This will complete one-sixteenth part of section *B*. Taking the true length of the rivet pitch 1″ to 2″ and 1″ as center, describe an arc; intersect this arc with the true length of the diagonal line 1′ to 2″ using 1′ as center and the intersection at 2″. Use the true length of the bottom rivet pitch 1′ to 2′. Describe arc using 1′ as a center; intersect this arc with the true length of the straight line 2′ to 2″ using 2″ as center and intersecting at 2′. This completes the development of one-eighth of section *B*. Advance in the same manner until straight line 0″ to 0′ is reached. This is also first line of development in section *C* and completes layout of section *B*.

The development of sections *C* and *D* is arrived at in same manner as the development of section *B*. Development of section *E* the same as section *A*, so that detailed description of the development of sections *C*, *D* and *E* will not be given.

In referring to tables of triangles in Figs. 3 and 4 it will be noticed three tables are shown in Fig. 3 and four tables are necessary in Fig. 4, the development of section *B*. This is necessary in order to ascertain the true lengths of the rivet pitch on top and bottom circumference line. In the development of section *A*, Fig. 3, we use one-sixteenth of the circumference for each pitch and no triangles are necessary.

Any misunderstanding that may arise, while working on above described layout will be cheerfully taken care of in the columns of The Boiler Maker by the author.

Master Boiler Makers' Convention

The fourteenth annual convention of the Master Boiler Makers' Association will be held at the Hotel Tuller, Detroit, Mich., May 22-25. A special committee, of which Leonard C. Ruber is chairman, will report on rules for standards and recommended practice. The other topics which will be reported upon with the names of the chairmen of the committees, follow:

"Are the new combustion chamber boilers as easy to maintain as the straight standard firebox?" Henry J. Raps, chairman.

"Finished material (boiler plates) should be sound and free from cracks, surface flaws and laminations, and no hammer dressing, patching, burning or electric welding is allowed." Charles P. Patrick, chairman.

"What are the best methods of detecting defective boiler sheets in the shop before going to the laying out bench and being put into service?" John J. Keogh, chairman.

"Hammer testing of staybolts on our modern locomotive boilers is now one of the most important duties of local boiler inspectors. What is the most up-to-date hammer for testing staybolts? Give shape and weight. Is it better to hammer test staybolts while the boiler is empty or when it is under hydrostatic pressure?" J. A. Holder, chairman.

"What is the standard method of applying flues in locomotive boilers; also in stationary boilers? Give each item separately in its regular order: (1) How should ends of flues be prepared? (2) Preparation of flue holes in sheets. (3) Copper ferrules, thickness and width. (4) Give length of flue projecting through sheet at both ends. (5) Tightening flues in sheet. Give standard tools for rollers, prosser tools, beading tools." Albert F. Stiglmeier, chairman.

"Is the use of automatic stokers on locomotive engines injurious to the firebox sheets? Do the firebox sheets crack more readily in a stoker-fired engine than in a hand-fired locomotive?" H. A. Bell, chairman.

"Care of watertube stationary boilers." J. J. Davey, chairman.

"Steam leaks and the bad effects on the boiler plate." D. A. Lucas, chairman.

"The life of the superheater tube and the number of safe-ends that should be applied before they are cut down for a smaller boiler." J. P. Malley, chairman.

"What experience has been had in connection with the electric weld heater?" John W. Holt, chairman.

Nation-Wide Conference of Foreign Traders to Meet in New Orleans

With registrations already received from 21 states and two foreign countries, plans for the New Orleans Foreign Trade Convention, May 2-3-4, are rapidly taking shape.

Emphasis will be laid on the importance of European markets to American foreign trade and prosperity. The opening session of the convention will consider a report on "European Conditions Today," specially prepared for this meeting by a committee of the National Foreign Trade Council.

In this same session, Dr. Jeremiah W. Jenks, Alexander Hamilton Institute, will discuss "European Progress During the Year." Some of the barriers encountered in trading with Europe will be described by W. F. Gephart, First National Bank of St. Louis; while methods of trading under abnormal conditions and in the face of depressed exchange, will be outlined by A. C. Kains, president of the Federal International Banking Company, New Orleans.

Delegates to the Foreign Trade Convention will be taken over the harbor of New Orleans on May 5, prior to the formal opening, as guests of the Port Commission.

Repairing Locomotives for Economy

Practically all railroad shops are now crowded to their full capacity with locomotives undergoing repairs. With insistent demands for motive power and with forces in many cases still disorganized from the strike, the situation is very trying to the foremen. When work is rushed, there is always a tendency to neglect details, and for that reason every foreman should impress upon his men that a locomotive poorly repaired usually wastes many times the amount that is saved by rushing it out of the shop. Some mechanics fail to realize how their work affects the operation of the locomotives, and the lack of such knowledge often leads to serious mistakes. For example, a boiler maker repairing ash-pans found that the section over the trailer wheel was sometimes cut by the flange on the trailer tire. To overcome the trouble, he raised the entire ash-pan closer to the mudring, not realizing that by so doing he was reducing the efficiency of the boiler and decreasing the capacity of the locomotive. Few men, unless they have had considerable experience, understand the necessity for accurately locating the stack and alining the exhaust nozzle so that the jet will be exactly in the center. Foremen should also impress upon the men the importance of careful work in applying cylinder and valve rings, in setting valves properly, in fitting up superheater units and steam pipes so that they will stay tight, and in fact all work that affects steam consumption. The price which the railroads pay for coal at present ranges from $3 to $6 per ton, so the cost of fuel for a single trip with a large locomotive may be from $60 to $120. Giving the shopmen an understanding of the cost of locomotive fuel and the extent to which slight errors may affect the coal consumption, should have a good effect in making them more accurate in their work, and insure that locomotives which have received repairs will operate with maximum economy.—*Railway Mechanical Engineer.*

Home-Made Equipment for the Boiler Shop

By C. E. Lester

In every issue of the trade magazines I look with interest for new devices or kinks in shop operation where "the other fellow" has accomplished results in a new or better way. I find all too few suggestions and frequently wish that the other fellow would "loosen up" with his ideas and publish some of the thousand and one new kinks that are developed daily. Perhaps others feel as I do and with this thought in mind I am submitting a few drawings of some home made devices of proven worth that are in almost daily use in a railroad shop. I claim none of them as my own; however, I see merit in them and I believe that others may care to make use of them.

Fig. 1 illustrates a large oil heater for mudring corners, throat sheet connections and other heavy work that gives an excellent heat. This tool is made from a globe valve body with some special brass fittings and common pipe and fitting—all of which may be found in any railroad shop.

In Fig. 2 is given a method of mounting a boiler test pump. The use of a 9 inch air pump bushed down on the air end for a boiler test pump developed the necessity for some convenient arrangement to make it portable. By mounting the pump on a two wheeled truck as illustrated the pump can readily be moved to its destination; the truck may also mount a tool box in which the fittings, gaskets, test gage, etc., are carried.

Fig. 3 illustrates dies for pointing staybolts. It will be observed that the contour of the die eliminates interference with the first thread on the bolts.

An adjustable holder-on and its details are given in Fig. 4. This tool can be made in any machine shop from rough stock or scrap axles or wrist pins and will be found invaluable for holding on rivets in narrow water spaces such as the flue sheet legs.

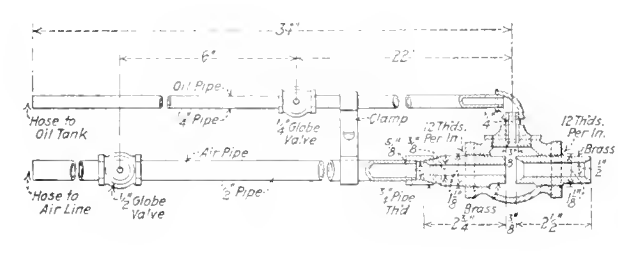


FIG. 1-OIL BURNER FOR HEATING HEAVY IRON

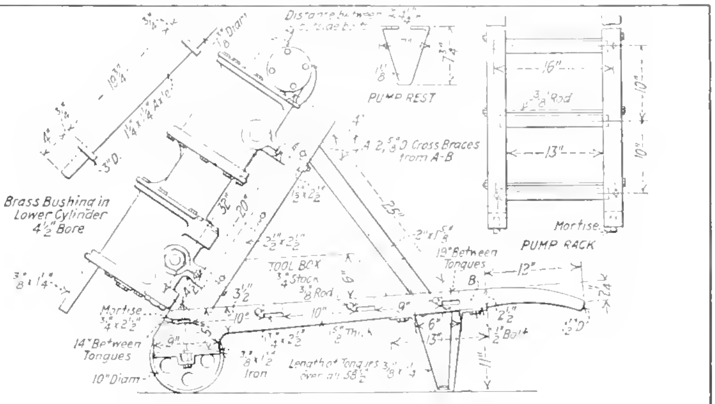
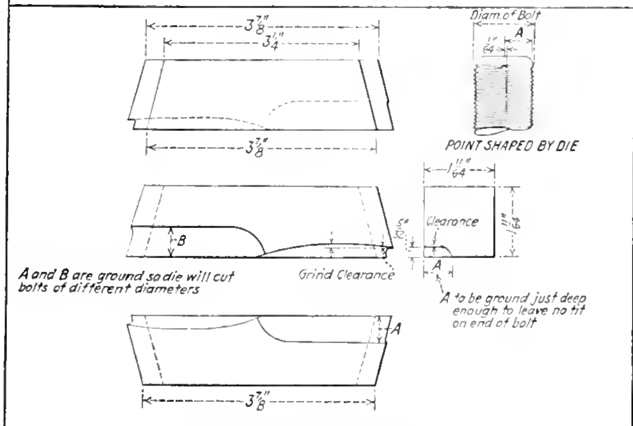


FIG. 2-BOILER TEST PUMP MOUNTING



DIAM OF BOLT	DIAM OF POINT AFTER SHAPING	VALUE OF A
1"	15/16"	[illegible]/64"
1 1/16"	1"	33/64"
1 1/8"	1 1/16"	35/64"

FIG. 3-DIE FOR POINTING STAYBOLTS

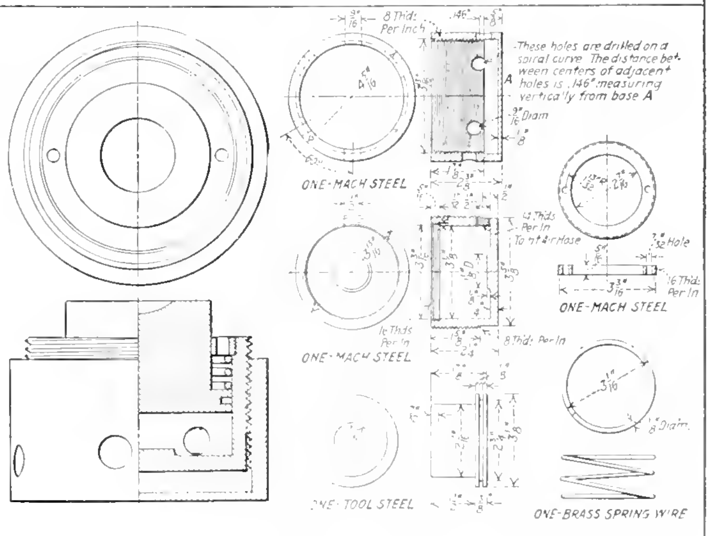


FIG. 4-ADJUSTABLE HOLDER ON

Easily Built Devices for Railroad Shop Service

Boiler Design in Relation to Maintenance*

Factors Entering Design and Construction of British Locomotives and Their Influence on Upkeep and Repair Problems

By A. E. Kyffin

In this paper it is not intended to consider the boiler in its functions as a steam producer, the object being to call attention to some of the more important details of locomotive type boilers in which considerable diversity of practice exists, and which, while they are but parts of the boiler, yet have an important bearing on the life and maintenance of it as a whole, more especially when considered from the running shed and repair shop point of view.

Tube Arrangement

Apart from the water-space stays there is no part of a boiler which causes more anxiety and trouble than the fire-[illegible] plate, and the extent and frequency of the trouble depend to a large extent on the arrangement of the tubes in this plate.

Broadly, there are two systems of arranging tubes, namely, vertical and horizontal rows, as shown in Figs. 1 and 2.

The claim generally made for the first system is, that by reason of the tubes being directly under one another there is less opportunity for scale to collect, and also that the steam bubbles are not impeded in their upward course; but when the two outer rows are considered in their relation to the flange of the plates it would seem that the small section presented by the aggregate of the bridges of metal offers but small resistance to the flexure of the plate due to the expansion of the tubes, and thus cracks are more readily developed than is the case with the far greater section offered at the outer rows with the horizontal rows of tubes. This is sometimes recognized and every other tube pitch left out in some designs. Many examples exist in which designers have crowded far too many tubes into the boilers with a view to getting "paper" heating surface, with the result that the bridges in the tubeplate are often as small as 5/8 inch; this not only leads to cracks at an early stage, but makes it next to impossible to remedy such cracks by the usual methods, as there is not sufficient metal to tap into. A further fault with such crowding is, that unless the water is very good the spaces between the tubes are rapidly made up, as it is next to impossible to wash out, however ample the provision made for so doing.

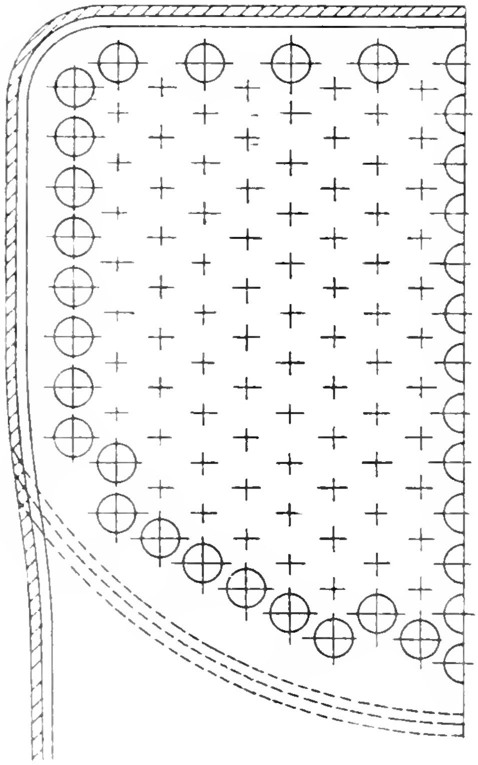


Fig. 1.—Tubes Shown in a Vertical Arrangement

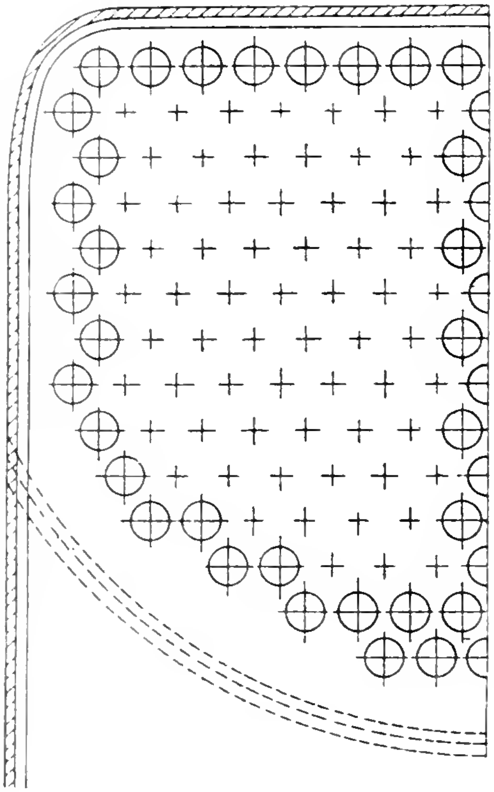


Fig. 2.—Horizontal Arrangement of Tubes

Another fault often found, which also follows from the desire to get a lot of tubes in, is the placing of tubes right into the radius of the flange of the plates; this practice cannot be too severely condemned.

If tubes were spaced so as to give say, a minimum of 7/8-inch bridge and were kept at least a tube diameter clear of the radius of the flange of the plates, there is little doubt but that the life of tubeplates would be prolonged and many anxious moments spared to those in charge of the engines; and it is extremely doubtful if, over a length of time, the boiler would prove any worse a steamer, for all railway men know that a large percentage of the tubes can be plugged before the steaming capacity drops.

Tubes are often placed too near the bottom of the barrel, with the result that washing out cannot be satisfactorily

*P[illegible] Institution of Locomotive Engineers at Manchester, England, [illegible] done and the circulation of the water along the bottom of the barrel into the front leg of the firebox is impeded; in most cases the bottom row and the outer tubes of the row above could be left out with advantage.

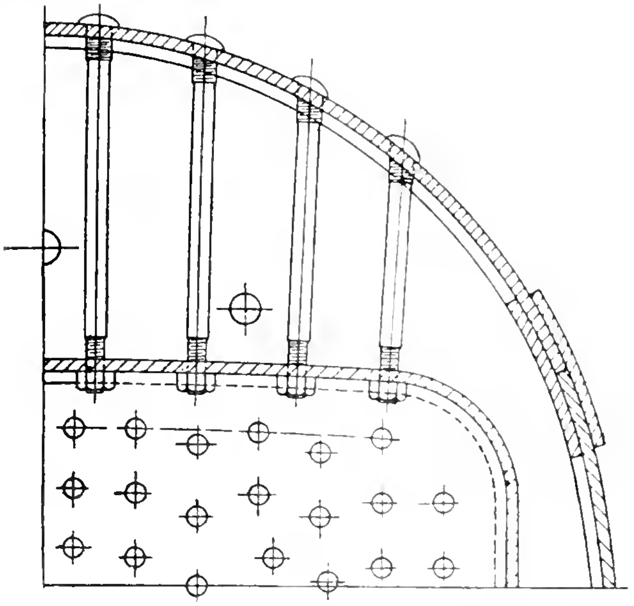


Fig. 3.—Firebox Stayed Direct to Shell with Straight Bolts

The last mentioned arrangement, which is by no means unknown, brings out in an acute degree the question of palm stays to the tubeplate, as the distance between the top row of water-space stays and the nearest tubes is considerable.

Although there are instances of boilers without palm stays, their place being taken by combining a small radius in the throat plate and the raising of the top row of water-space stays to the utmost, yet in most cases they are used in some form, but their record of breakage is very high and many different forms have been evolved to mitigate the trouble, such as anchoring them several feet away from the tubeplate to give flexibility, and even of articulating them. In some designs the forged stay, into which the copper stay is screwed, stops short of the tubeplate by 1-inch or even more, whereas in other examples the forged stay is brought right up to the plate, each form having its advocate.

Another practice in palm stays is used on a few railways,

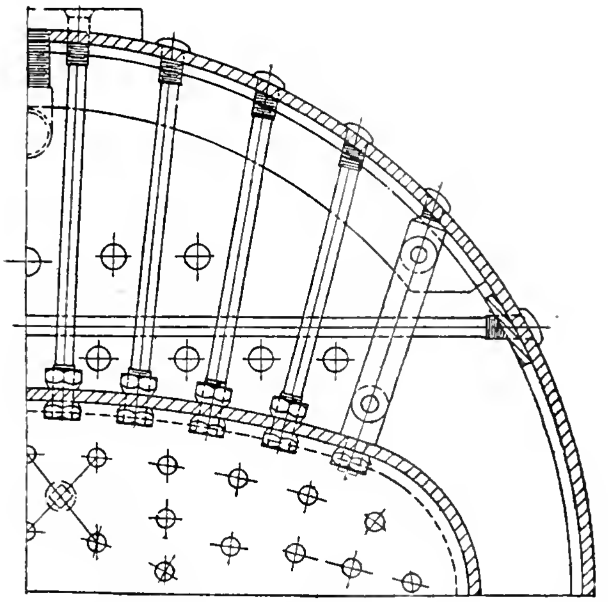


Fig. 4.—With Direct Stays an Arch Crown is Advisable

namely, the provision of what are practically longitudinal stays between the tube plates along the barrel bottom; this system, however, makes the washing out of the barrel more difficult and the stays are difficult to replace.

With the growth of boilers the practice of providing stays to the tube plates in the tube area has increased to some extent, these being usually in the form of solid rods, although stay tubes, after marine practice, are sometimes found. The

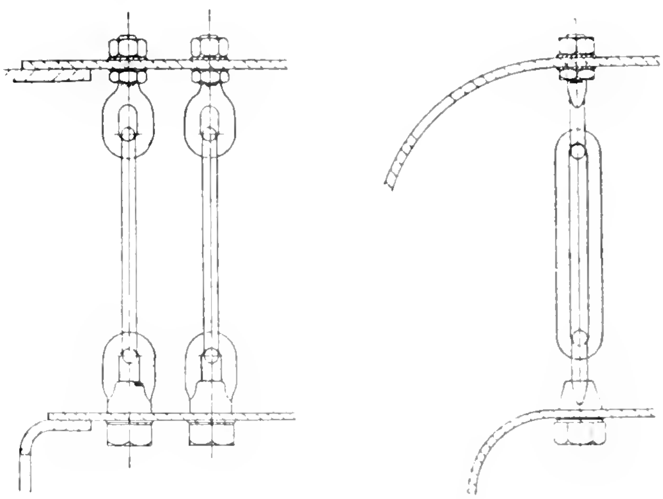


Fig. 5.—Two Methods of Staying Without Screwed Stays

need for such stays is questionable in view of the enormous holding power of tubes, and it would be valuable information if evidence could be produced that tube leakage had been reduced or the life of the tube plate prolonged by their use.

WATER SPACE STAYS

Many efforts have been made by designers to either eliminate or render these less liable to breakage, the best

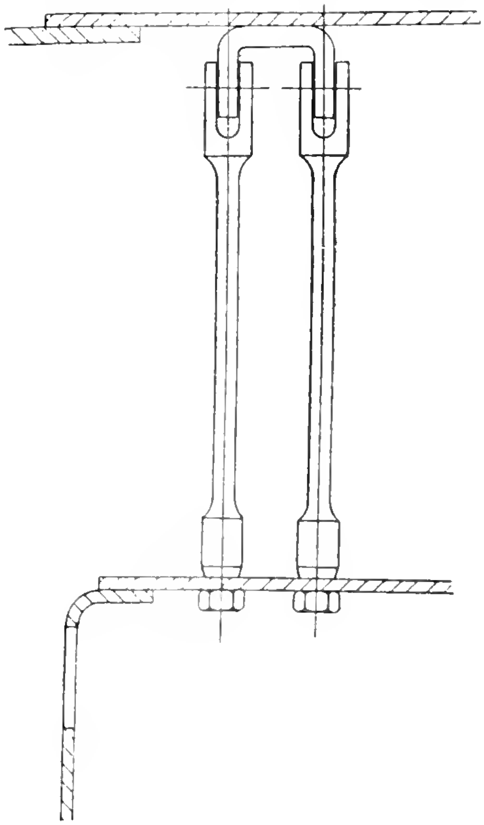


Fig. 6.—Alternative Method of Staying

known of the devices for doing away with stays being the Jacob-Schupert firebox; but as this form of construction does not lend itself to fireboxes carried between the frames it need not be considered in connection with British locomotives. Concerning the second class, in American practice, to some

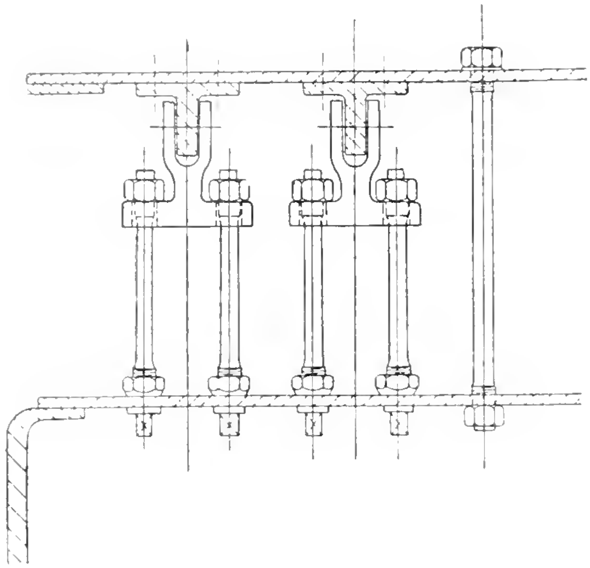


Fig. 7.—Type of Stays to Provide for Vertical Expansion

extent at least, flexible stays of the Tate type are fitted either to the whole firebox or more commonly to the breakage area. To the best of the author's belief, these have not been tried in Great Britain, and it would be interesting to know why.

Locomotive engineers seem to have settled down to the practice, with copper fireboxes, of using plain copper stays, but there is by no means any standard as regards the diameter of such and areas supported by them. When boiler pressures were about 160 pounds, the usual rule was to use

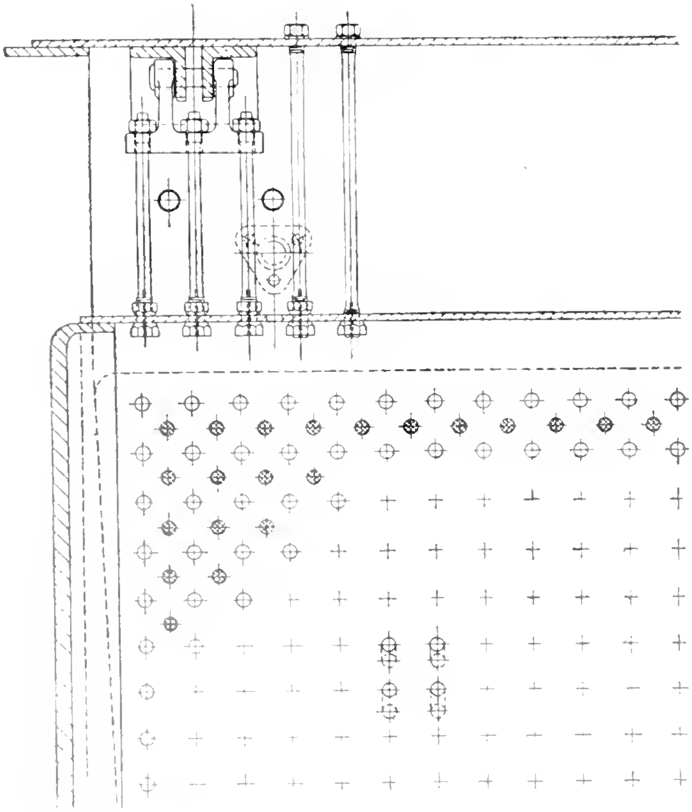


Fig. 8.—Another Method of Staying for Expansion

about 1-inch diameter stays supporting an area of about 16 square inches, but with the rise in pressures the area has naturally been reduced and in some cases 1⅛-inch diameter stays used, either throughout the firebox or in the top rows; but it is questionable whether the latter is advisable, as it means that a very large stay has to be put in for renewals, and even a 1⅛-inch stay is a comparatively rigid bar which offers considerable resistance to the bending action imposed by the upward expansion of the firebox. It would be instructive if two boilers were made identical in all respects, saving that one should have, say, 1-inch stays spaced as widely as possible, and the other, say, ¾-inch stays spaced to suit the permissible tensile stress on the stays and a record kept over a period of the stay failures and the extent of the bulging of the plates.

It is highly desirable that water-space stays be made as long as possible, even if the firebox width, and therefore the number of tubes, suffer slightly; also more consideration should be given than is often the case to the angle at which the stays enter the copper plate, as a bad angle of entry tends towards leaky stays.

An interesting method of endeavoring to mitigate the breakage of stays in the area at the top front corners of the side plates is employed by two large railways the author is acquainted with, namely, the provision of an additional stay

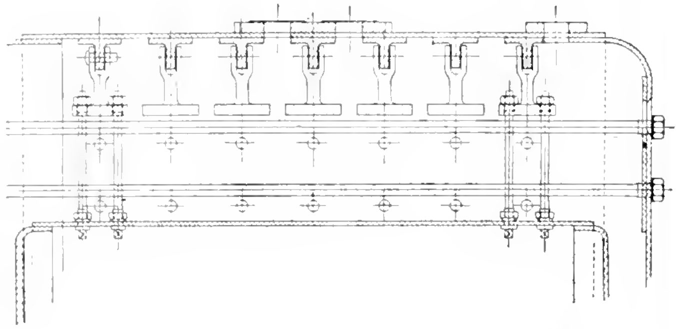


Fig. 9.—Firebox Stays Arranged in Groups

in the center of each ordinary spacing (see Fig. 8); but this arrangement would appear only to have the effect of rendering this area very rigid.

In the boilers of many locomotives built in this country for overseas lines the water-space stays have detector holes about ⅛-inch diameter drilled in them, either for a distance of about 1¼ inch—that is, far enough to bring the hole into the water space—or else drilled right through and the outer end laid over or filled with a copper plug. Provided the water is reasonably good, these holes show the presence of fractured stays, but with water which rapidly deposits scale the fracture, which ordinarily is of slow development, is filled up as it grows and the object of the hole is defeated.

On the question of whether it is best to turn the threads off the portion of the stays between the inner and outer plate or to retain them opinions differ, as many engineers adopt the one form and many the other, but it seems reasonable to argue that the turned-down stay is the more flexible, and is also less liable to collect scale.

The pitch of stays in relation to the flanges of the tubes and door plates, foundation and firehole rings, requires attention, and many examples can be found in which the stays are brought unnecessarily close to such parts, thus preventing the firebox from breathing freely and also providing areas in which scale can readily accumulate, but from which it is difficult to clean it.

Firebox Crown Stays

Even at this late day locomotive engineers have not decided the question as to whether the Belpaire form is the best or not; thus while many large boilers of this type are built, there is also a large number of the round-topped variety; but if the latter gives perfect results, why do engineers continue to build the Belpaire box, which is undoubtedly heavier and more expensive? The answer to the question whether one type is better than the other can only be given by engineers who have both types under their supervision as regards running and repairs.

The roof bar or girder stay, while far from dead, is not so much used—for main line engines—as before: it is heavy, and it cannot be denied that it seriously hinders the cleaning of the firebox top and is an admirable collector of scale. The alternative is, of course, the direct stay commonly in the form of a bolt screwed into the steel firebox shell top and the copper plate, being riveted over at the steel plate and nutted under the copper (see Fig. 3); but it is not unusual to have nuts both above and below the latter.

If plain direct stays are used, it is good practice to arch the crown of the copper box and arrange the stays radially so as to get as many full threads of the stays in both plates, but especially in the steel plate, as the stay end is riveted over at that end. Fig. 4, which gives the cross section of the two boxes—one with radial stays and the other with vertical stays.

There are many other forms of roof stays devised to obviate the disadvantages of screwing the stays into the outer plate, some of which are shown in the accompanying sketches, Figs. 5 and 6. These all have their good features, but all are more expensive than the plain stay.

It is usual to provide for the upward expansion of the tubeplate by arranging for the front two, three or even four rows of vertical stays to have a certain amount of free vertical movement, most commonly by attaching them in groups of twos or threes in a tee sling supported from the outer wrapper plates, Figs. 7 and 8; there are, of course, other devices such as the provision of a few rows of stays of the types shown in Figs. 5 and 6. Cases are not uncommon in which such expansion stays are fitted above the back or door plates of fireboxes, but as this plate is rigidly attached to the shell plate by the firehole, the need for such flexible stays is questionable. One British railway, at least, builds all its boilers with the firebox crown stays slung in groups, as in Fig. 9.

(To be continued)

Second Revision of the A. S. M. E. Boiler Code

Continuation of Proposed Changes in Provisions Dealing with the Construction of Power Boilers

The first section of the revised Boiler Code was published on page 233 of the August, 1922, issue of The Boiler Maker; the second section appeared on page 281 of the October issue; and the third on page 73, of the March issue. Below a continuation of the work of the committee on revision is given.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th street, New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A. S. M. E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

Par. 248 Combine this Paragraph with Par. 249 and Insert Following New Paragraph:

Cutting of Plates

248 PLATES MAY BE CUT BY MACHINING, PUNCHING, SHEARING OR CUTTING BY THE ELECTRIC ARC OR GAS, PROVIDED ENOUGH METAL IS LEFT AT ANY UNFINISHED EDGES TO MEET THE REQUIREMENTS OF PARS. 249, 253, AND 257.

Par. 250 Revised:

250 A firetube boiler WITH TUBES UNDER 5 INCHES DIAMETER shall have THE [both] ends of the tubes FIRMLY [substantially] rolled and beaded, or rolled and welded at the firebox or combustion-chamber end, AND ROLLED AND BEADED AT THE OTHER END. IN THE CASE OF TUBES UNDER 1¼ INCHES DIAMETER, THE TUBES MAY BE EXPANDED BY THE PROSSER METHOD IN PLACE OF ROLLING. IN THE CASE OF TUBES 5 INCHES IN DIAMETER AND OVER, THE TUBES SHALL BE SECURED BY RIVETING OR OTHER APPROVED METHOD AT BOTH ENDS. IF WELDED, THE WELDING SHALL BE AROUND THE EDGE OF THE BEAD OR IF THE TUBE IS NOT BEADED THE TUBE SHEET SHALL BE CHAMFERED OR RECESSED TO A DEPTH AT LEAST EQUAL TO THE THICKNESS OF THE TUBE. IN NO CASE SHALL THE TUBE END EXTEND MORE THAN ⅜ INCH BEYOND THE TUBE SHEET.

Par. 251 Revised:

251 The ends of all tubes, suspension tubes and nipples shall be flared not less than ⅛ inch over the diameter of the tube hole on all watertube boilers and superheaters, or they may be flared not less than ⅛ inch, rolled and beaded, or flared, rolled and welded. WHERE SPECIAL REDRAWN PIPE AS PROVIDED IN PAR. 21 IS USED FOR TUBES IN WATERTUBE BOILERS, THE MINIMUM NUMBER OF THREADS SHALL CONFORM WITH THE VALUES GIVEN IN TABLE 8. THE CLOSED ENDS OF THE STUB TUBES SHALL BE WELDED BY THE FORGING PROCESS.

Fig. 20 Change Note at Bottom of Figure to Read:

Dimensions OF FINISHED HEADS may be larger or 1/10 smaller than those shown. Fillets under heads may be used but are not required. Change Caption to Read: Acceptable Forms of FINISHED Rivet Heads.

Par. 253 Revised:

253 *Drilling of Holes.* ALL HOLES IN BRACES, LUGS AND SHEETS FOR RIVETS OR STAYBOLTS SHALL BE DRILLED, OR THEY MAY BE PUNCHED, AT LEAST ⅛ INCH LESS THAN FULL DIAMETER FOR MATERIAL NOT MORE THAN 5/16 INCH THICK,

AND AT LEAST $\frac{1}{4}$ INCH LESS THAN FULL DIAMETER FOR THICKER MATERIAL, NOT MORE THAN $\frac{5}{8}$ INCH THICK.

HOLES SHALL NOT BE PUNCHED IN MATERIAL MORE THAN $\frac{5}{8}$ INCH THICK.

FOR FINISHING THE RIVET HOLES, THE PLATES, BUTT STRAPS, BRACES, HEADS AND LUGS SHALL BE FIRMLY BOLTED IN POSITION BY TACK BOLTS, FOR FINAL DRILLING OR REAMING TO FULL DIAMETER.

THE FINISHED HOLES MUST BE TRUE, CLEAN AND CONCENTRIC.

PAR. 255 REVISED:

255 *Rivets.* Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal in strength to the bodies of the rivets. Forms of FINISHED rivet heads that will be acceptable are shown in Fig. 20.

PAR. 256 REVISED:

256 Rivets shall be SO DRIVEN AS [machine-driven wherever possible with sufficient pressure] to fill the [rivet] holes PREFERABLY BY A MACHINE WHICH MAINTAINS THE PRESSURE UNTIL NO PART OF THE HEAD SHOWS RED IN DAYLIGHT [and shall be allowed to cool and shrink under pressure]. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

PAR. 257 REVISED:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled to an angle not sharper than 70 degrees to the plane of the plate, and as near thereto as practicable. Every portion of the UNFINISHED [sheared] surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than $\frac{1}{8}$ inch. Calking shall be done with a [roundnosed] tool OF SUCH FORM THAT THERE IS NO DANGER OF SCORING OR DAMAGING THE PLATE UNDERNEATH THE CALKING EDGE.

PAR. 258 REVISED:

258 *Manholes and Handholes.* An elliptical manhole opening shall be not less than 11 by 15 inches, or 10 by 16 inches in size. A circular manhole opening shall be not less than 15 inches in diameter. A handhole opening in THE SHELL OF a boiler OR DRUM, the greatest dimension of which exceeds 6 inches, shall be reinforced in accordance with the rules for manholes.

PAR. 260 REVISED:

260 Manhole frames on shells or drums when used shall have the proper curvature, and on boilers over 48 inches in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 21. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (REQUIRED BY PAR. 180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening. WHEN A FLANGED MANHOLE FRAME IS USED THE FLANGED PORTION OF THE FRAME MAY BE CONSIDERED AS REINFORCEMENT UP TO A HEIGHT (h) OF THREE TIMES THE FLANGE THICKNESS (SEE FIG. 20½).

PAR. 261 REVISED:

261 The strength of the rivets in shear on each side of a manhole frame or reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole, or other opening, SUCH AS THOSE CUT FOR STEEL NOZZLES AND BOILER FLANGES, OVER 3-INCH PIPE SIZE.

PAR. 268 REVISED:

268 *Threaded Openings.* ALL PIPE THREADS SHALL CONFORM TO THE AMERICAN PIPE STANDARD AND ALL [a pipe] connections 1 inch in diameter or over shall have not less than the number of threads given in Table 8.

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 pounds per square inch, a NOZZLE OR SADDLE FLANGE [connection] riveted to the boiler to receive a flanged fitting

Fig. 20½.—Cross-Section of Flanged Manhole Frame

shall be used for all pipe openings over 3-inch pipe size.

IF SPECIAL REDRAWN PIPE, NOT TO EXCEED 1½ INCH STANDARD PIPE SIZE, MADE FROM LAPWELDED IRON OF PUDDLED STOCK AND TESTED TO 1,000 POUNDS HYDRAULIC PRESSURE, IS USED IN WATERTUBE OR PORCUPINE BOILERS FOR A WORKING PRESSURE NOT TO EXCEED 200 POUNDS PER SQUARE INCH, WHEN SCREWED IN THE SHEET, WHICH HAS A WALL THICKNESS AT LEAST 50 PERCENT GREATER THAN THE WALL THICKNESS REQUIRED BY THE CODE FOR TUBES OF WATER-TUBE BOILERS, THE MINIMUM NUMBER OF THREADS SHALL CONFORM WITH THE VALUES GIVEN IN TABLE 8 AND THE CLOSED ENDS OF THE STUB TUBES MAY BE WELDED BY THE FORGING PROCESS.

PAR. 269 REVISED:

269 *Safety Valve Requirements.* Each boiler RATED TO DISCHARGE OVER 2,000 POUNDS OF STEAM PER HOUR AT THE ALLOWED PRESSURE SHALL HAVE TWO OR MORE SAFETY VALVES WHEN THE GENERATING CAPACITY OF THE BOILER EXCEEDS 2,000 POUNDS PER HOUR. THE METHOD OF COMPUTING THE STEAM GENERATING CAPACITY OF THE BOILER SHALL BE AS GIVEN IN PAR. 421 OF THE APPENDIX [except a boiler for which one safety valve having a relieving capacity of 2,000 pounds per hour or less, is required by the rules].

PAR. 272 REVISED:

272 ALL safety valves shall be so CONSTRUCTED THAT NO SHOCKS DETRIMENTAL TO THE VALVE OR TO THE BOILER ARE PRODUCED [of such a type that] AND SO THAT no failure of any part can obstruct the free and full discharge of steam from the valve. Safety valves may be of the direct spring-loaded pop type with seat and bearing surface of the disk inclined at any angle between 45 degrees and 90 degrees to the center line of the spindle. The valve shall be rated at a pressure 3 percent in excess of that at which the valve is set to blow.

Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening at the base of the valve, provided the movement of the valve is gradual so as not to induce lifting of the water in the boiler.

[All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve.] Weighted lever safety valves shall not be used.

PAR. 273 REVISED:

273 Each safety valve 1 INCH SIZE AND LARGER shall be plainly marked by the manufacturer IN SUCH A WAY THAT THE MARKINGS WILL NOT BE OBLITERATED IN SERVICE. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates permanently secured to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer

b The nominal diameter

c The steam pressure at which it is set to blow

(*d* Blow down, or difference between the opening and closing pressures) (*e*) *d* The weight of steam discharged in pounds per hour at a pressure 3 percent higher than that for which the valve is set to blow

(*f*) *e* A.S.M.E. Std.

PAR. 274 REVISED:

274 The MINIMUM AGGREGATE [total] relieving capacity of ALL OF the safety valve or valves required on a boiler shall be not less than that determined on the basis of 6 pounds of steam per hour per square foot of boiler heating surface for watertube boilers. For all other types of power boilers, the total relieving capacity shall be not less than that determined on the basis of 5 pounds of steam per hour per square foot of boiler heating surface. IN MANY CASES A GREATER RELIEVING CAPACITY OF SAFETY VALVES WILL HAVE TO BE PROVIDED THAN THE MINIMUM SPECIFIED BY THIS RULE AND IN EVERY CASE THE REQUIREMENT OF PAR. 270 SHALL HOLD. [For boilers with maximum allowable working pressures above 100 pounds and on the basis of 3 pounds of steam per hour per square foot of boiler heating surface for boilers with maximum allowable working pressures at or below 100 pounds per square inch.]

The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose, only the tubes, fireboxes, shell, tube sheets and the projected area of headers need be considered. The minimum number and size of safety valves required shall be determined on the basis of the total relieving capacity and the relieving capacity marked on the valves by the manufacturer. WHERE THE FIRING CONDITIONS ARE CHANGED TO INCREASE THE RATE OF STEAM GENERATION, THE SAFETY VALVE CAPACITY SHALL BE INCREASED TO MEET THE NEW CONDITIONS AND BE IN ACCORDANCE WITH PAR. 270.

PAR. 275 REVISED:

275 IF THE SAFETY VALVE CAPACITY CANNOT BE COMPUTED, OR IF IT IS DESIRABLE TO PROVE THE COMPUTATIONS, IT [Safety valve capacity] may be checked in any one of the three following ways, and if found insufficient, additional capacity shall be provided:

[remainder of paragraph unchanged]

PAR. 276 REVISED:

276 When two or more safety valves are used on a boiler, they may be either separate or twin valves made by mounting individual valves on Y-bases, or duplex, triplex or multiplex valves having two or more valves in the same body casing. THE VALVES SHALL BE MADE OF EQUAL SIZES, IF POSSIBLE, AND IN ANY EVENT IF NOT OF THE SAME SIZE, THE SMALLER OF THE TWO VALVES SHALL HAVE A RELIEVING CAPACITY OF AT LEAST 50 PERCENT OF THAT OF THE LARGER VALVE.

PAR. 277 REVISED:

277 The safety valve or valves shall be connected to the boiler independent of any other steam connection, and attached as close as possible to the boiler, without any unnecessary intervening pipe or fitting. SUCH INTERVENING PIPE OR FITTING, IF USED, SHALL NOT BE LONGER THAN THE FACE TO FACE DIMENSION OF THE AMERICAN EXTRA-HEAVY IRON FLANGED TEE FITTING OF CORRESPONDING SIZE SHOWN IN TABLE 17 AND FIG. 33. Every safety valve shall be connected so as to stand in an upright position, with spindle vertical, when possible.

PAR. 278 REVISED:

278 Each safety valve shall have AT LEAST A full-sized direct connection to the boiler. No valve of any description shall be placed between the safety valve and the boiler, nor on the discharge pipe between the safety valve and the atmosphere. When a discharge pipe is used, it shall be not less than the full size of the valve, and shall be fitted with an open drain to prevent water from lodging in the upper part of the safety valve or in the pipe. EACH VALVE SHALL HAVE AN OPEN DRAIN TAPPED FOR DRIP PIPE THROUGH THE CASING BELOW THE LEVEL OF THE VALVE SEAT. IN THE CASE OF FIRE-TUBE BOILERS, THE SAFETY VALVE OPENINGS SHALL BE NOT LESS THAN THOSE CORRESPONDING TO SAFETY VALVES HAVING THE INTERMEDIATE LIFTS AND CORRESPONDING RELIEVING CAPACITIES GIVEN IN TABLE 15.

PAR. 279 REVISED:

279 If a muffler is used on a safety valve it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit. When an elbow is placed on a safety valve discharge pipe, it shall be located close to the safety valve outlet or the pipe shall be securely anchored and supported. All safety valve discharges shall be so located or piped as to be carried clear from running boards or working platforms used in controlling the main stop valves of boilers or steam headers.

Where discharge pipes are used, THEY SHALL BE AS SHORT AND AS STRAIGHT AS POSSIBLE AND the cross-sectional area at any point shall be at least equal to the combined areas of the discharge outlets of the valves discharging therethrough. Ample drainage shall be provided at or near each safety valve and where the water of condensation may collect.

PAR. 280 REVISED:

280 When a boiler is fitted with two or more safety valves on one connection, this connection to the boiler shall have a cross-sectional area not less than the combined area BASED ON THE NOMINAL DIAMETERS of all of the safety VALVE CONNECTIONS [valves with which it connects].

PAR. 281 REVISED:

281 Safety valves shall operate without chattering and shall be set and adjusted as follows: To close after blowing down not more than 4 PERCENT NOR LESS THAN 2 PERCENT OF THE SET PRESSURE, BUT NOT LESS THAN 2 POUNDS IN ANY CASE. [4 pounds on boilers carrying an allowed pressure less than 100 pounds per square inch gage. To close after blowing down not more than 6 pounds on boilers carrying pressures between 100 and 200 pounds per square inch gage inclusive. To close after blowing down not more than 8 pounds on boilers carrying over 200 pounds per square inch gage.]

PAR. 282 REVISED:

282 To insure the valve being free, each safety valve shall have a substantial lifting device by which the valve may be raised from its seat at least 1/16 inch when there is no pressure on the boiler. THE VALVE SHOULD NOT BE LIFTED UNLESS THERE IS SUFFICIENT STEAM PRESSURE ON THE BOILER TO BLOW ALL DIRT AND SCALE CLEAN FROM THE SEAT.

PAR. 286 REVISED:

286 A safety valve over 3-inch size, used for pressures greater than 15 pounds per square inch gage, shall have a flanged inlet connection. The dimensions of flanges subjected to boiler pressure shall conform to the American Standard given in Table [s] [16 and] 17 of the Appendix [for the pressures therein specified], except that the face of the safety valve flange and the nozzle to which it is attached may be flat and without the raised face for pressures up to and including 250 pounds per square inch. For higher pressures, the raised face shall be used.

PAR. 287 REVISED:

287 When the valve body is marked [with the letters A.S.M.E. Std.] as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

PAR. 289 REVISED:

289 Every safety valve used on a superheater, discharging superheated steam, shall have a steel body INCLUDING ALL PARTS WHICH COME IN CONTACT WITH THE STEAM BE-

TWEEN THE INLET AND OUTLET, with a flanged inlet connection, and shall have the seat and disk of nickel composition or equivalent material, and the spring fully exposed outside of the valve casing so that it shall be protected from contact with the escaping steam.

PAR. 290 REVISED:

290 Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other outside steam connection, the area of opening to be at least equal to the aggregate [nominal] area BASED ON NOMINAL DIAMETERS of all of the safety valves to be attached thereto. An internal collecting pipe, splash plate or pan may be used, provided the total area for inlet of steam thereto is not less than TWICE [one and one-half times] the aggregate area of the CORRESPONDING NOMINAL DIAMETERS OF THE attached safety valves. The holes in such collecting pipes shall be at least 1/4 inch in diameter and the least dimension in any other form of opening for inlet of steam shall be 1/4 inch.

PAR. 299 CANCEL PRESENT WORDING OF REVISION AS PUBLISHED IN JULY ISSUE OF MECHANICAL ENGINEERING AND SUBSTITUTE THE FOLLOWING:

299 *Fittings.* FLANGED CAST IRON PIPE FITTINGS INCLUDING THOSE FOR STEAM AND FOR FEED WATER AND WHERE THE PRESSURES DO NOT EXCEED 160 POUNDS SHALL CONFORM TO THE AMERICAN STANDARD GIVEN IN THE APPENDIX. IF THE FITTINGS ARE BELOW THE WATER LINE THEY SHALL BE EXTRA HEAVY.

FOR PRESSURES EXCEEDING 160 POUNDS PER SQUARE INCH, FITTINGS MORE THAN 2-INCH PIPE SIZE OR EQUIVALENT CROSS-SECTIONAL AREA, SHALL BE OF CAST OR FORGED STEEL. (SEE PARS. 9 AND 245.) THE DIMENSIONS OF THE FLANGES AND DRILLING SHALL CONFORM TO THE AMERICAN STANDARD GIVEN IN TABLE 17.

FOR PRESSURES EXCEEDING 250 POUNDS PER SQUARE INCH, THE FLANGE THICKNESS, AND THE THICKNESS OF THE BODIES SHALL BE INCREASED TO GIVE AT LEAST THE SAME FACTOR OF SAFETY AS THE FITTINGS SPECIFIED IN THE TABLE, WHEN USED FOR THE MAXIMUM PRESSURES PERMITTED IN THE CODE.

THE FACE OF THE FLANGE OF A SAFETY VALVE, AS WELL AS THAT OF A SAFETY VALVE NOZZLE, MAY BE FLAT AND WITHOUT THE RAISED FACE, FOR PRESSURES NOT EXCEEDING 250 POUNDS BUT SHALL HAVE THE RAISED FACE FOR HIGHER PRESSURES.

THE NUMBER OF BOLTS IN A FLANGE MAY BE INCREASED, PROVIDED THEY ARE LOCATED ON THE STANDARD BOLT CIRCLE. OTHER EXCEPTIONS ARE NOTED IN PAR. 12. TABLES 16 AND 17 DO NOT APPLY TO FLANGES ON THE BOILER SIDE OF STEAM NOZZLES, OR TO FLANGES LEFT BY THE MANUFACTURER AS PART OF THE BOILER; AND DO NOT APPLY TO FITTINGS DESIGNED AS PART OF THE BOILER.

PAR. 306 REVISED:

306 Each superheater shall be EQUIPPED [fitted] with AT LEAST ONE DRAIN SO LOCATED AS WILL MOST EFFECTIVELY PROVIDE FOR THE PROPER OPERATION OF THE APPARATUS.

PAR. 311*a* REVISED:

311*a* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 pounds per square inch, each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be OF extra heavy CONSTRUCTION [except that]. On a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required. TWO INDEPENDENT VALVES OR A VALVE AND A COCK MAY BE COMBINED IN ONE BODY PROVIDED THE COMBINED FITTING IS THE EQUIVALENT OF TWO INDEPENDENT VALVES OR A VALVE AND A COCK SO THAT THE FAILURE OF ONE TO OPERATE COULD NOT AFFECT THE OPERATION OF THE OTHER.

PAR. 312 REVISED:

312 A bottom blow-off pipe when exposed to direct furnace heat shall be protected by fire-brick, OR OTHER HEAT RESISTING MATERIAL SO ARRANGED THAT THE PIPE MAY BE INSPECTED [a substantial cast iron removable sleeve or a covering of non-conducting material].

PAR. 314 CANCEL PRESENT WORDING OF REVISION AS PUBLISHED IN JULY ISSUE OF MECHANICAL ENGINEERING AND SUBSTITUTE THE FOLLOWING:

314 THE FEED WATER SHALL BE INTRODUCED INTO A BOILER IN SUCH A MANNER THAT THE WATER WILL NOT BE DISCHARGED DIRECTLY AGAINST SURFACES EXPOSED TO GASES OF HIGH TEMPERATURE, OR TO DIRECT RADIATION FROM THE FIRE, OR CLOSE TO RIVETED JOINTS OF SHELL OR FURNACE SHEETS.

PAR. 315 OMIT FIRST SECTION OF REVISION AS PUBLISHED IN AUGUST ISSUE OF MECHANICAL ENGINEERING, AND RETAIN LAST SECTION OF PARAGRAPH AS FOLLOWS:

315 In Fig. 22 is illustrated a typical form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shell.

PAR. 316 CANCEL PRESENT WORDING IN BOILER CODE AND REPLACE BY SECOND SECTION OF REVISED PAR. 315 AS PUBLISHED, AS FOLLOWS:

316 In THESE AND other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

PAR. 321 REVISED.

321 The water connections to the water column of a boiler [shall be of brass] WHEN PRACTICAL, shall be provided with a cross AT EACH RIGHT-ANGLE TURN to facilitate cleaning. FOR PRESSURES OF 200 POUND STEAM PRESSURE OR LESS, THE WATER CONNECTION, IF PIPE IS USED, SHALL BE OF BRASS.

PAR. 323 REVISED:

323 *Methods of Support.* A horizontal-return-tubular boiler over 78-inch in diameter shall be supported from steel lugs by the outside suspension type of setting, independent of the boiler side walls. The lugs shall be so designed that the load is properly distributed between the rivets attaching them to the shell and so that no more than two of these rivets come in the same longitudinal line on each lug. The distance girthwise of the boiler from the centers of the bottom rivets to the centers of the top rivets attaching the lugs shall be not less than 12 inches. The other rivets used shall be spaced evenly between these points. If more than four lugs are used they shall be set in four pairs, THE LUGS OF EACH PAIR TO BE SPACED NOT OVER 2 INCHES APART AND THE LOAD TO BE EQUALIZED BETWEEN THEM.

Additional revisions of the Boiler Code will appear in the May issue.

Mechanical Stokers—Sales, Horsepower, and Kinds of Installation for the Months of January and February, 1923.

The Department of Commerce, Washington, D. C., announces that according to the returns made to the Bureau of the Census the sales of mechanical stokers for the months of January and February, 1923, were as follows:

Month	Number of establishments reporting	Number of stokers sold during the month	Total horsepower of stokers sold	Installed under firetube boilers: Total number	Installed under firetube boilers: Total horsepower	Installed under watertube boilers: Total number	Installed under watertube boilers: Total horsepower
January	15	145	83,270	29	3,400	116	79,870
February ...	15	[1]129	66,619	9	1,172	120	65,447

[1]Exclusive of two stokers equaling 150 horsepower installed under furnaces.

The Boiler Maker

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We GUARANTEE that of this issue 4,800 copies were printed, that of these 4,800 copies, 4,300 were mailed to regular paid subscribers; 22 were provided for counter and news company sales; 74 were mailed to advertisers; 114 were mailed to employees and correspondents, and 290 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 19,300, an average of 4,825 copies a month.

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CONTENTS

Over a billion dollars for railroad equipment has been authorized for expenditure during the present year. Of this amount $160,000,000 is to be devoted to locomotive construction. From January 21, 1922, to March 15, 1923, the railroads of the country placed orders for 4,219 new locomotives and of this number 2,106 have already been put in service. The reports since the first of the year up to April 1 show orders for 1,358 locomotives and the requirements for new power have not yet reached the peak.

Resolutions recently adopted by the American Railway Association form the basis of a definite policy for the railroads to follow in meeting an expected record demand on transportation facilities. These resolutions deal with car repairs, fuel requirements, maintenance of way, coal movement, building programs, car loading and mileage, storage facilities, car shortage and the like. One of the resolutions provides that by October 1, 1923, locomotives awaiting heavy repairs be reduced to a basis for the entire country of 15 percent.

At present the number of locomotives in line for general repairs is about 21 percent. The fulfilment of the program outlined would add 1,250 to the number of locomotives for service. The objective of 15 percent is lower than has prevailed for years and is beyond hope of attainment unless personnel and equipment are able to handle the increased output. This demand for speedier turn-around in the shop is a problem that the boiler department must meet and means that the forces of first class boiler makers should be expanded to take care of the work. Men who have drifted into other lines of work will find that better opportunities now exist in their own trade of boiler making. Those now engaged in the shops will have a prominent place in making the transportation program a reality.

The convention season is almost here and plans for the two principal meetings for the members of the boiler industry are nearly completed. The programs for the annual meeting of the American Boiler Manufacturers' Association and for that of the Master Boiler Makers' Association convention appear elsewhere in this issue. No effort is being spared by the officers of the associations to make the meetings this year the best ever held and it only remains for the members to do their part by attending and entering fully into the proceedings.

As has been customary in the past, the American Boiler Manufacturers' Association will combine its business sessions with sports and social activities, selecting as the scene of its meetings this year The Homestead at Hot Springs, Va. The secretary of the association suggests that members make reservations as early as possible in order that no difficulty be experienced on arriving at the hotel. The dates for the meetings are June 4, 5, and 6.

The Master Boiler Makers' convention is scheduled for May 22 to 25 at the Hotel Tuller, Detroit, Mich. In connection with the meeting the Boiler Makers' Supply Men's Association will also hold its convention and present the products of its members for the inspection of the master boiler makers. The opportunity for the supply men to make this feature of the convention of maximum benefit to all concerned is better than ever before. This is particularly true because of the decision to omit the exhibits at the June convention in Chicago of Section V—Mechanical of the American Railway Association. The Master Boiler Makers' convention offers an excellent chance to present shop equipment and supplies covering at least one section of the railroad field.

The secretary of the Supply Men's Association has sent notices of the convention and exhibits to all manufacturers who sell equipment to railroads and who are interested in the boiler department. These manufacturers have been invited to join the association and exhibit their products. Application for membership and exhibit spaces can be obtained from W. H. Dangel, secretary of the Boiler Makers' Supply Men's Association of the Lovejoy Tool Works, Chicago, Ill.

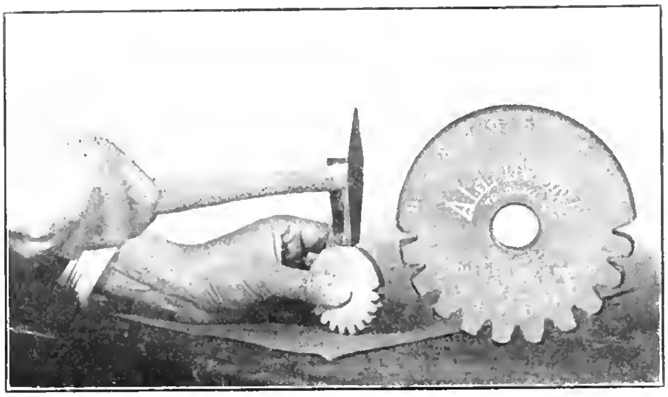
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

All-In-One Steel Figures Save Time

An ingenious arrangement of steel figures, with important advantages over the individual steel figures or letters commonly used, is shown in the illustration and has been placed on the market recently by Marburg Bros., Inc., New York. The method of using these figures is plainly shown at the left in the illustration and a close-up view at the right.

Many obvious advantages result from this arrangement including in the first place the saving of a large amount of



View Showing Method of Using All-In-One Steel Figures

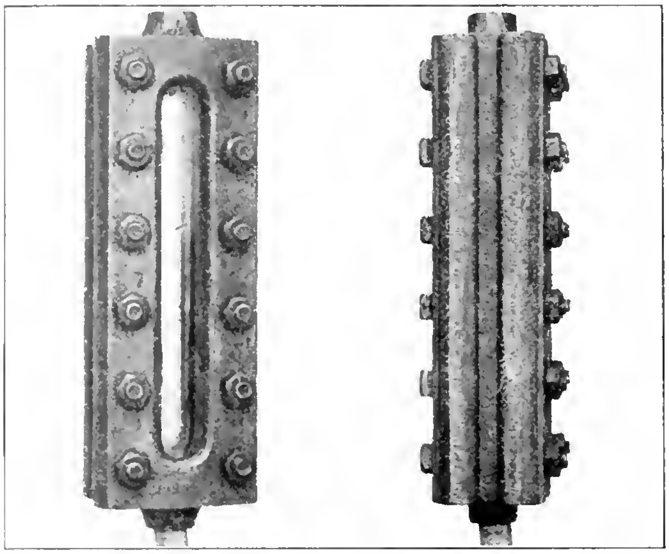
time formerly spent hunting for the correct individual figures. The All-In-One is more convenient to handle, with less danger of smashed fingers, and vertical figures or letters are produced with ease. In addition, the speed of stamping is greatly increased and the figures never get upside down. Shattering is prevented and the general appearance of the lettering is improved. Individual figures cannot be lost.

The All-In-One can be furnished for metal, wood, or leather in seven sizes from 1/16 in. to 3/8 in. In case alphabets are desired they can be furnished on three discs.

Water Gage Glass Designed to Be Unbreakable

The Duplex glass water gage, shown below, is a new development recently brought out by the Duplex Glass Water Gage Company, Youngstown, Ohio. The following advantages, substantiated by actual service tests, are claimed for this glass: It permits accurate reading of water level from both sides of the gage, enabling the water level to be determined by both the engineer and fireman from their respective positions in the cab. The glasses used are 1/2 inch thick and smooth on both sides, eliminating the possibility of corrosion which makes reading difficult. The glass will last indefinitely barring accidents and, having no intricate parts to get out of order, it can easily be assembled by anyone and kept in good operating condition. The Duplex glass embodies all the advantages of the tubular glass without its objectionable features. It eliminates the danger of flying glass in the event of breaking. It will withstand indefinite pressure and can be applied to steamboat, stationary, and other types of boilers as well as locomotive boilers. No additional illumination is required at night other than that provided for the types of glass now in use. A composition gasket, made from sheet Permanite packing is used between the glass and central metal part to make a steam tight joint.

This gage was applied to a switching locomotive in steel mill service for ten months with no maintenance or repair



Duplex Water Gage Glass for Boilers

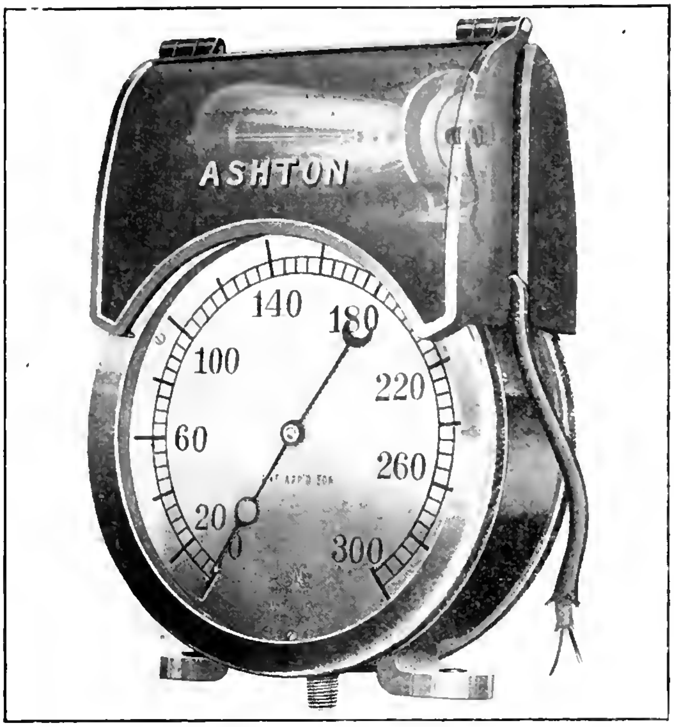
cost. The gaskets were renewed at the end of this period. The same gage was then applied to a railroad switching locomotive and remained in service three months with no repairs or renewals. It was removed at this time on account of the locomotive being transferred from the Youngstown territory. Each of the above tests was unofficial, being made as experiments with the consent of the local managements.

Double Dial Locomotive Steam Gage

The double dial locomotive steam gage, illustrated, is a recent development of the Ashton Valve Company, Boston, Mass. It is particularly designed for use on large oil-burning locomotives and locomotives having large fireboxes with boiler heads extending back into the cabs, requiring two steam gages, one visible to the engineman on one side of the cab, and one for the fireman on the other side.

The gage is constructed with two hands and also two dials which are opposite and parallel to each other. The hands work clockwise on one dial and contraclockwise on the other. Illumination for both dials is provided in the practical and compact manner illustrated. The particular advantage of this gage is in eliminating the necessity of two gages which take up valuable space in the cab and require duplicate piping.

The gage housing is self-contained and is equipped with

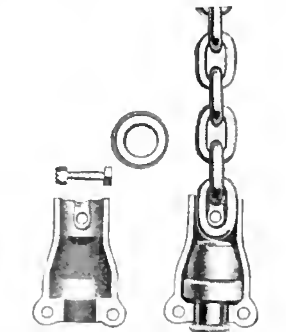


Double Dial Steam Gage with Electric Light Bulb

an A. R. A. standard receptacle for lamp bulbs, substantially fastened to the top of the gage. The arrangement is such that light is reflected downward on the two dials in such a manner as not to interfere with the vision of the engineman. The dials are finished either silvered or black, as specified, and are regularly graduated to 300 lb. or 400 lb. These gages are made only in the $3\frac{3}{4}$-inch dial size, being contained in dust-proof brass, or iron cases, with threaded valve brass rings and having $\frac{1}{4}$-inch standard pipe thread connection. When desired, gages are furnished without the electric light attachment.

Chain Hoist Swivel Hook

A new style of ball bearing swivel hook connection for the ends of hoisting chains has been developed by the Wright Manufacturing Company, Lisbon, Ohio, as illustrated. This swivel eliminates the necessity of pulling and tugging at the load to get it into the desired position. Ease of swiveling permits heavy loads to be turned on this hook by a small expenditure of energy.



Ball Bearing Swivel Hook

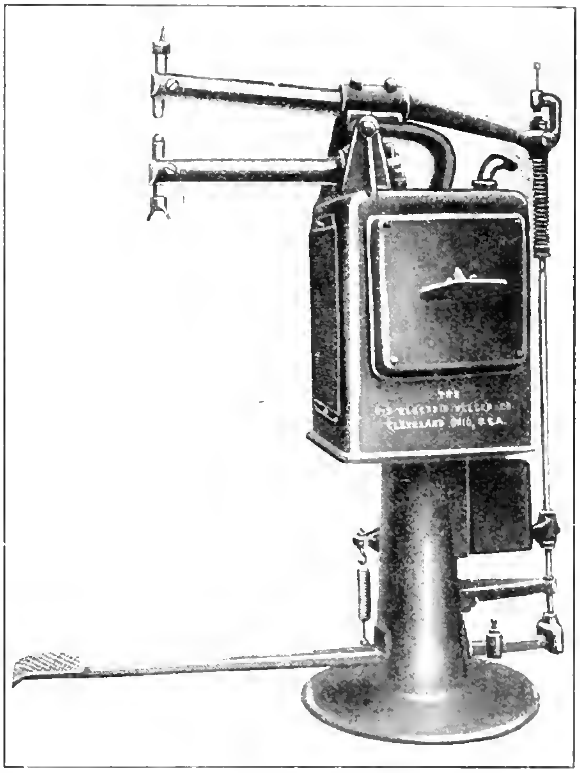
In construction the hook connection is practically indestructible, with a large drop forged housing enclosing the entire bearing and chain connection. The housing is split its entire length, being clamped together by three steel bolts, held by castellated nuts. The top bolt passes through the lower chain link but only acts as a reinforcement to the connections and clamp for the housing as the load on the hoist hook is supported by bosses forged in each half of the housings, these bosses meeting each other inside the lower chain link so that the hook is held on an area of forged steel equal to the clearance on the inside of the chain link. The two lower bolts of the connection serve only as housing clamps.

The lower ball race rests on a shoulder at the bottom of the housing. The upper race rests on the top of the large capacity balls which easily accommodate any overload hung on the hook. The straight shank of the hook passes up through the lower part of the housing and the inside of the ball races and is retained in place by a washer and extra large nut screwed and riveted to the threaded end of the shank.

The ball bearings are thoroughly lubricated so as to insure easy frictionless action and to overcome all difficulty in positioning heavy loads.

Spot Welding Machine

The U. S. Electric Welder Company, 327 Permanent Building, Cleveland, Ohio, has placed on the market a new type of welder, S A F, for light and medium stock. The internal automatic reactance prevents breakdown at overload and enables the welder to handle heavy stock without overheating. The automatic switch is equipped with magnetic blowout, removable contacts and is enclosed. A 5-point pivot switch provides different voltages at the welding point, which are water-cooled by means of a new system. All mechanical movable parts are of a special alloy or cast steel, therefore light.



U. S. Spot Welder

About four seconds per weld is required for 3/16 inch stock and about 4,000 welds per hour can be made on 1/16 inch bright sheets.

Robert F. Eissler, for the past two years assistant to the vice-president of the Chicago Pneumatic Tool Company, Chicago, Ill., has resumed his former position as district manager for the company at Pittsburgh, Pa.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Boiler Explosions

Q.—Why is a boiler when blowing up always thrown forward instead of backward?—C. B.

A.—A boiler on exploding may be thrown in any direction depending on where the rupture occurs in the boiler and the type.

There may be some other matter in connection with this question that you want information on, but, if we understand your question correctly, our reply seems sufficient.

Details of Thermic Syphon Layout

Q.—Please show me the method of laying out a "Nicholson Thermic Syphon."—J. F. D.

A.—A typical installation of three Nicholson syphons is shown in Fig. 1, as ordinarily applied in the fireboxes of locomotive boilers. A general view of the syphon is illustrated in Fig. 2. The neck of the syphon at *a* fits in the diaphragm plate to which it is welded as indicated at *b*, Fig. 3.

The syphon is made usually from one plate of firebox steel, ⅜ inch in thickness, being first cut to shape, then punched for the staybolts and then formed under hydraulic pressure with suitable dies to the shape shown in Fig. 2. After the body of the syphon is pressed, the top flange *b* is turned under

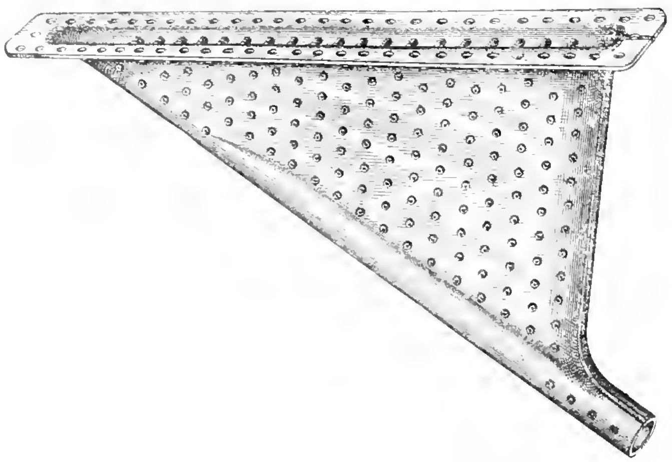


Fig. 2.—General View of Syphon

hydraulic pressure and the edges *c* are welded by the gas or electric method.

The construction, Fig. 4, is not produced to the required dimensions of the syphons, Fig. 1. It is enlarged somewhat to show the general method of producing sections on *w-w*, *x-x* and *y-y*. Owing to the sloping sides, the sections *w-w* and *y-y* are ellipses when the sections *o-o* at the ends of the

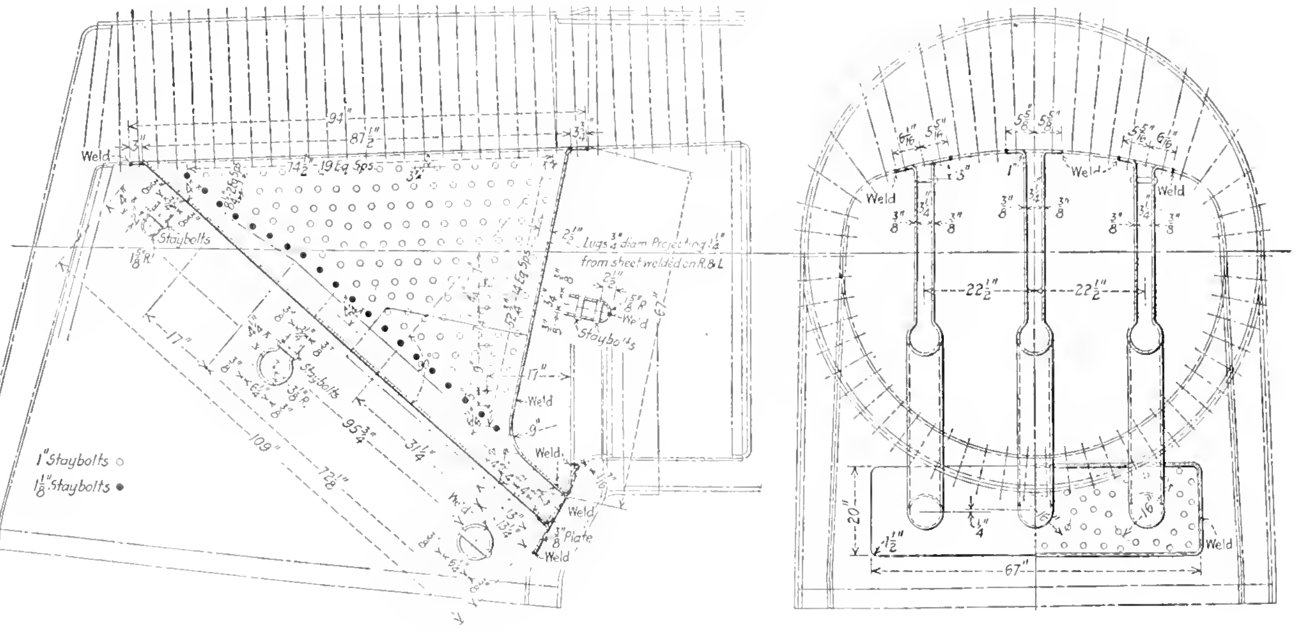


Fig. 1.—Side and End Elevations of Three Syphon Firebox Installation

plan view are semi-circular; or, if sections on *w-w* and *y-y* are semi-circular sections, *o-o* would be elliptical. Owing to the shape of the syphon and as it is formed from a single sheet, a developed pattern can cover only the principal dimensions, allowances must therefore be made for the curvature in the flange and where the circular section gradually runs into the elliptical section *w-w*.

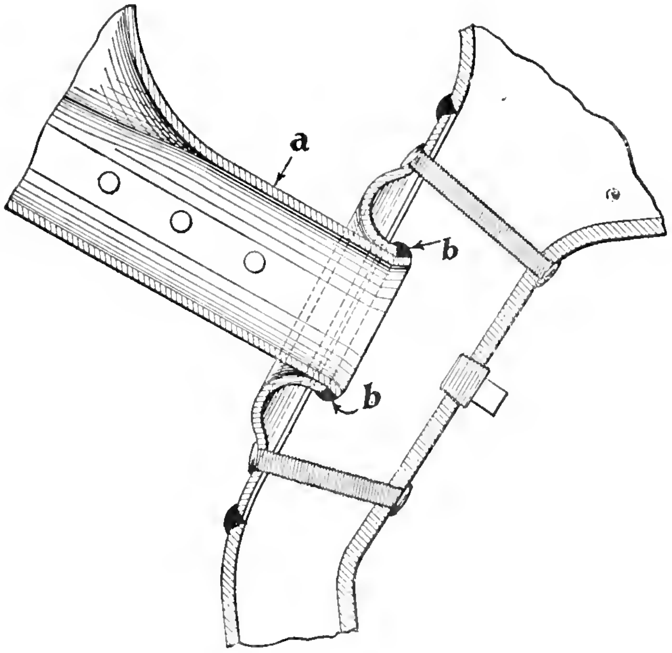


Fig. 3.—Connection of Syphon with Throat Sheet

Fig. 4 is drawn to the neutral layer of the plate and the curved section spaced off as required for securing the development lines *1-1*, *2-2* and *3-3*, etc. The one-half pattern, Fig. 5, is laid off from Fig. 4 and, as the respective construction lines are numbered the same in both views, the layout should be readily understood.

Effect of Mercury in a Boiler

Q.—If a pint or quart or even a gallon of mercury is placed in a steam boiler what effect will it have on it?—C. J. V.

A.—The specific gravity of mercury is 13.6 therefore the mercury would settle to the bottom of the boiler and remain there under working conditions. Mercury boils at a temperature of 357 degrees C. Under a disturbed condition, as when the mass is poured into the boiler, it would break up into globules. The specific heat of mercury is much less than that of water, being 0.0333. It would therefore absorb the heat more rapidly as it requires 1/30 or 0.0333 times the heat required to raise the temperature of water one degree F. If a large quantity of mercury is, for example, at the bottom of a tubular boiler the only possible effect that I can see is that it may lead to a violent ebullition of steam or to foaming.

Large Tank Problems

Q.—Having been a subscriber to The Boiler Maker a good many years, and seeing that you answer questions on laying off to subscribers, I wish to submit the following:

1. How to lay off an oil fuel tank 100 feet diameter or over?
2. Could a conical roof be laid off *plate by plate* by versed sine and chord, to save the cost of laying plates out in mass to mark (would top overlap of seam have a different length of chord and radius to bottom)?
3. Thirty or 40 feet high not particular to size in example, and if clinker built would the *camber* in top and bottom edge be a negligible quantity (but show how to get *it*)?

1a. Could bottom be marked off without laying plates out in mass to mark?—F. W. J.

A.—The conical roof layout and calculations will be given in answer to this question which in general covers the same conditions involved in the plating for the cylindrical section of the tank. Fig. 1 illustrates conventionally the section ele-

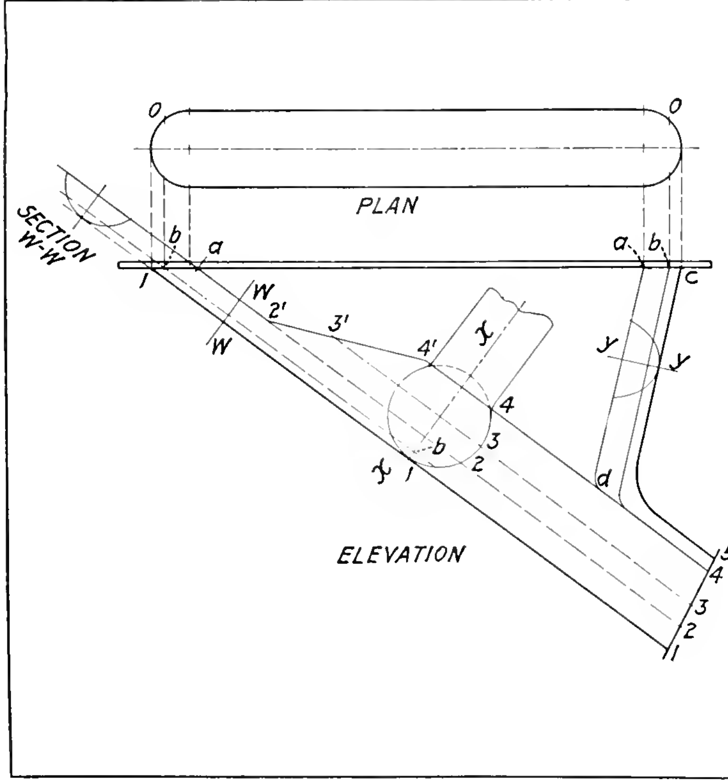


Fig. 4.—Construction Details of Syphon Layout

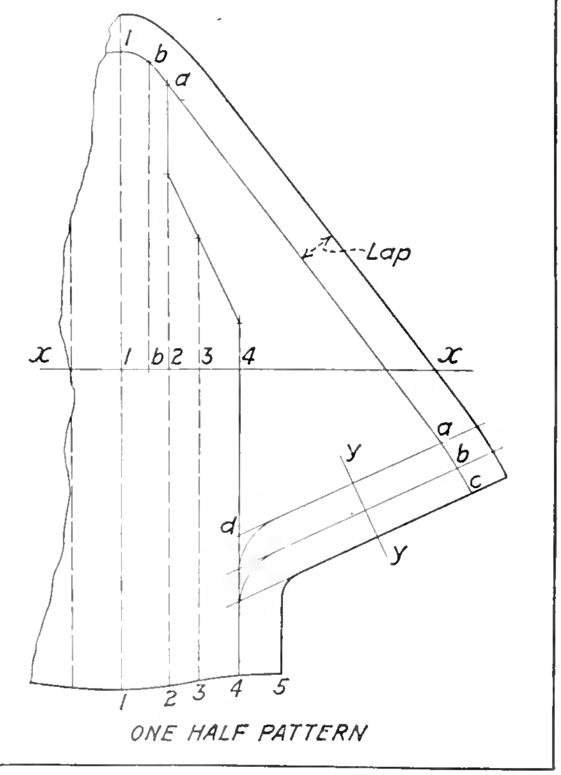
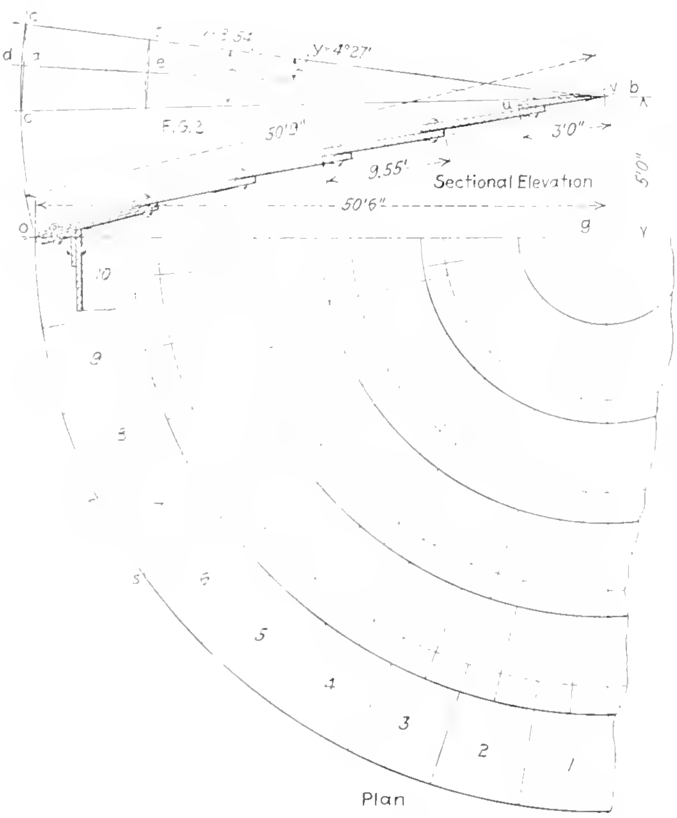


Fig. 5.—One Half Pattern of Thermic Syphon

vation and a one-fourth plan of the roof segments. The lower ring in each quarter is made of 10 segments and in the roof there are 5 rings, each of which is 9.55 feet in length measured as shown in the elevation. The top row or ring of segments is capped with a dished circular head. The number of segments in each of the overlapping rings depends on the general design required to meet the most economical use of the material available. This question will not be



Figs 1 and 2—Plan and Elevation of Conical Roof Tank

considered in this case. To illustrate the conditions arising in the segment developments and calculations a solution is given for one of the segments in the lower ring, as follows:

The roof diameter taken to the overhang end *o* equals 50½ × 2 = 101 feet.

The circumference equals 3.1416 × 101 = 317.3 feet.

There are 40 sections in the outer ring, so that the arc length of one section along *r-s* equals 317.3 ÷ 40 = 7 feet 11 13/16 inches.

Height of roof measured as indicated in the sectional elevation is 5 feet. Length of the hypothenuse *o-b* of the right angle triangle *o-g-b* equals

$$\sqrt{50\tfrac{1}{2}^2 + 5^2} = 50 \text{ feet } 9 \text{ inches.}$$

From these data the calculations of the angle between the sides of the segment 7 and the versed sine will be determined for the camber. Referring to Fig. 2, which shows the graphical construction of the pattern, the radius for describing the arc *c-c* is 50 feet 9 inches and the arc length is 7 feet 11 13/16 inches.

The length of the arc *c-c*, Fig. 2, is to the circumference of the circle of which it is a part, as the number of degrees in the angle *x* is to 360 degrees. Thus angle *x* equals

$$\frac{360 \times 7\ 15/16}{3.1416 \times 101} = 8°\ 54' \text{ and angle } y = \frac{8°\ 54'}{2} = 4°\ 27'$$

Sine 4° 27' = 0.07759

Length *a-c* = *bc* × sine of angle 4° 27' = 50¾ × 0.07759 = 3 15/16 feet.

$ab = \sqrt{50\tfrac{3}{4}^2 - 3\ 15/16^2} = 50.6$ feet.

Versed sine or distance *a-d* equals 50.75 — 50.6 = 0.15 feet = 1.8 inches.

The length *b-e* = *bd* — *de* = 50¾ — (9.55 feet + 1.8 inches) = 41.05 feet.

The length *f-d* = *L-c* — 9.55 = 50.75 — 9.55 = 41.2 feet.

The distance *cf* = 41.2 × sine 4° 27' = 41.2 × 0.07759 = 3.2 feet.

In Fig. 3 is shown the development of the pattern for segment 7. Line *a-e* is made 9.55 feet in length. Lines *c-c* and *f-f* are drawn through points *a* and *e* respectively, and at right angles to *a-e*. Make *a-4* on line *a-e* 1.8 inches; from point *e* lay off the same distance. This length is the camber depth. The camber line may be developed in several ways. In this case, draw a circle with *a-4* as a radius, divide one-quarter into equal parts as *1-2-3-4*. Divide *a-c* into the same number of equal divisions, as *c-d-e-a* and erect perpendiculars to *a-c*. On lines drawn from *e* and *d* set off respectively the lengths *3-n* and *3-m*.

Through the points *c*, 2', 3', 4 draw the camber line. At the small end make a similar development. Extend the camber line beyond the points *c* and *f* to take care of the lap. From point 4 at the large end run off with a traveling wheel on each arc length *4-c* a distance of 3 15/16 inches plus the necessary lap. Likewise at the bottom lay off on arcs *4-f* from point 4 a distance of 3.2 feet and draw in the sides *c-f* and *c-f*, through the points so located. This pattern can now be used for marking off the remaining 39 sections. Rivet holes should be marked and punched on the rivet lines and used in marking off the other sections. This method of obtaining the segment size and shape is applicable to the other segment sections in the remaining rings. The pattern for the dished head is to be laid off with the radius *u-V*, making the dish diameter equal *u-v-u*.

The same procedure is followed in the layout of a segment

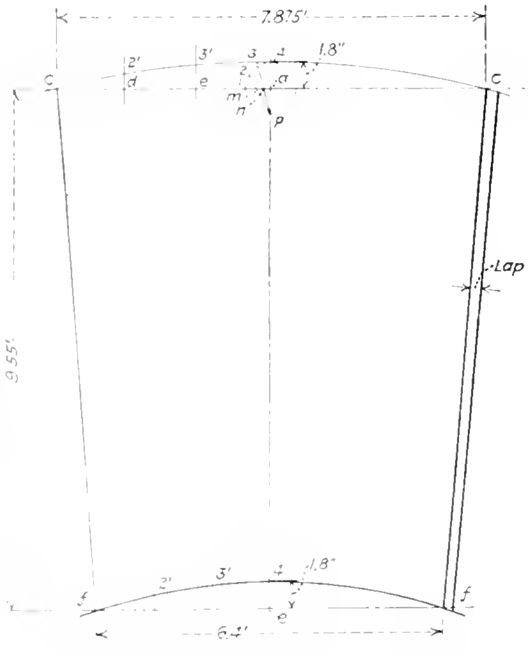


Fig. 3—Layout of Plate in Conical Roof Tank

of the other roof courses. The number of sections in these courses can be different to suit the best use of material available; but have the joints staggered.

The camber of the shell plate is so slight on account of the large diameter of the tank that it need not be taken into account. Camber calculations for this part of the layout if required would be made as already given and the plate stretchouts would be figured from the *neutral line*.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Temporary Method of Repairing a Cracked Firebox Side Sheet

The sketches show a repair which was done to the firebox of an express locomotive to enable the engine to obtain a better mileage before being sent into the shops. The side sheet was found to be cracked about $2\frac{1}{2}$ inches long between the stays, the copper being deteriorated in this neighborhood and thinned to 0.13 inch. The thinning did not cover a large area and the remainder of the plate was in good condition.

The boiler was allowed to work for some time before the crack went through and commenced to leak. It was then decided to fit specially made studs and caps in place of a patch. These were made as shown in Figs. 3 and 4. Three holes were drilled and screwed and the studs drawn up the water space by string until the square portion entered the hole. They were then screwed in by a wrench fitting on the square portion which was then sawn off. A copper washer, Fig. 5, was then fitted to cover the area under the caps and the caps screwed on the studs close to one another, care being taken that the studs were not turned out during the operation. The extent of the crack is shown in Fig. 6 and the completed repair in Figs. 1 and 2. The working pressure of the boiler is 175 pounds per square inch and the studs did not leak excepting when the boiler was cooling. The engine was able to run a further 24,000 miles at the end of this period when it was run down and sent to the shops where a patch was fitted. This method of repair is quite good and safe and is superior to the lock stud method when the plates are thin.

Crewe, England. "Boilers."

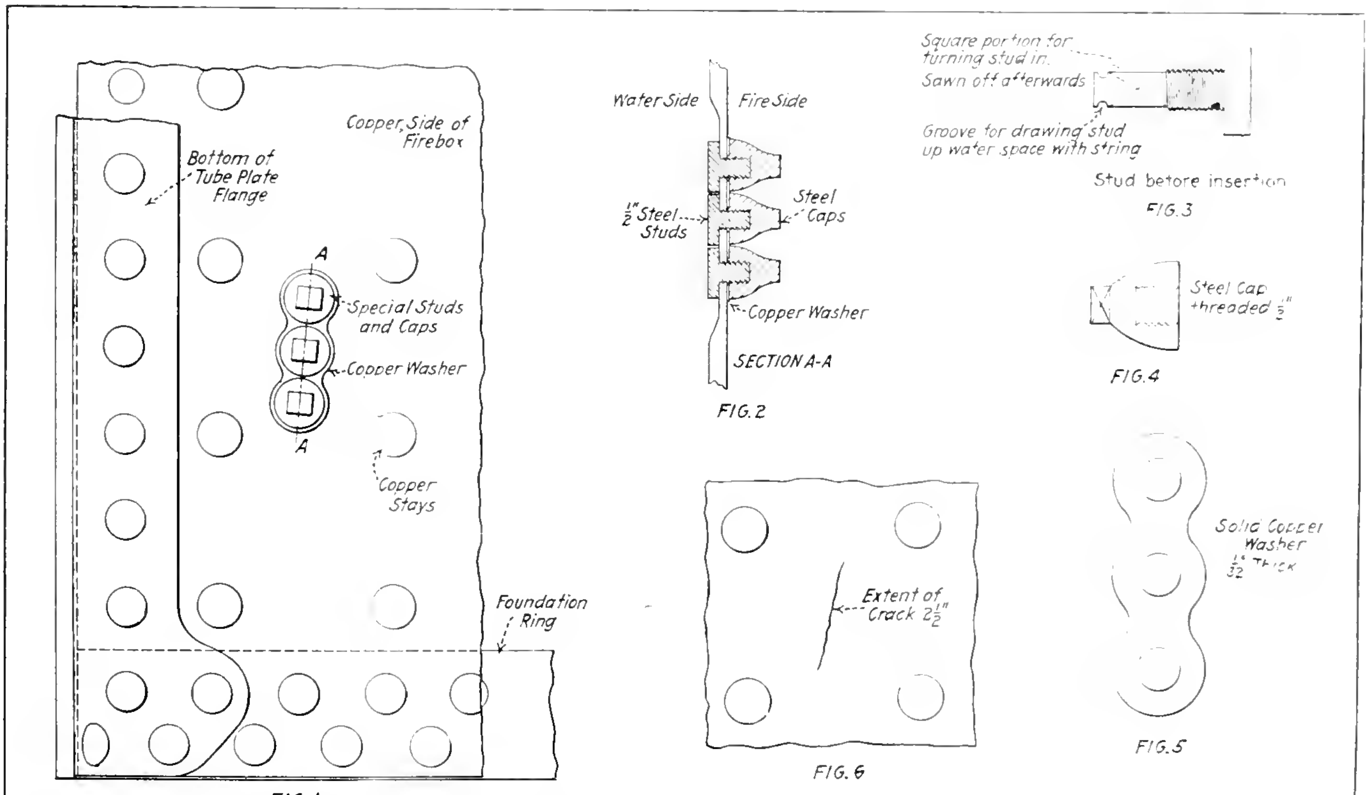
A New Field for Boiler Disasters

The following interesting news item appeared in a recent issue of a North Dakota newspaper:

"In a threshing machine explosion that tore the steam engine to fragments, scattering heavy parts sixty rods from where the machine stood, Gunder and Lars Larson, brothers, age 55 and 59 years, were instantly killed and five other workmen injured.

"The accident occurred yesterday afternoon at the Vaagen farm five miles from Carpio. A defective safety valve which failed to operate when a pressure of 300 pounds of steam was generated is blamed for the tragedy. The victims were blown to pieces, fragments of their bodies being picked up a hundred yards from where the engine stood."

Sounds somewhat as though they were testing the safety valve with a boiler full of live steam at 300 pounds pressure, doesn't it?



Locomotive Firebox Repair Details

If this news item is true it simply proves the writer's contention that MOST boiler explosions are preventable.

Newark, N. J. N. G. Near.

An Old Time Oil Field Boiler

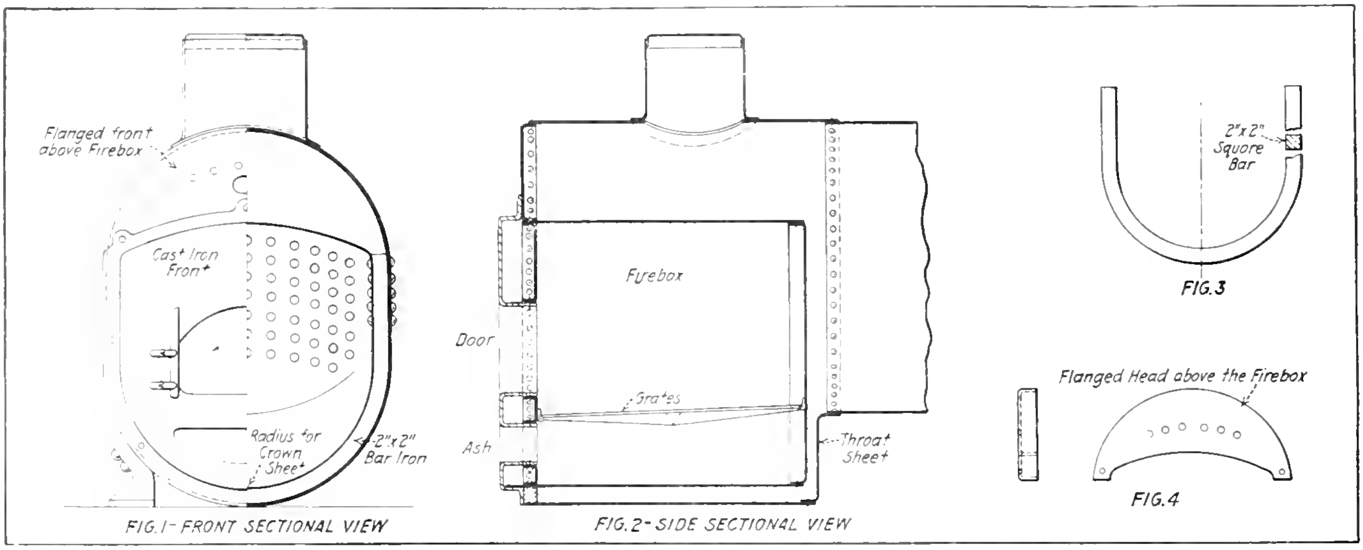
The accompanying illustrations show what we used to call the Wood and Mann type of boiler which was used extensively in the oil fields of Canada and also to a great extent in Pennsylvania. The sectional front and side views of the boiler are given in Figs. 1 and 2. It will be seen from these sketches that there was no water front, and only a 2-inch space left between the firebox sides and the outside shell. A segment was flanged and fitted to the top of the firebox and attached to the crown sheet and to the reinforcing bar. Otherwise the front was left open.

Details of Boiler

The section of the front containing the firedoor and draft door was of cast iron; this front being bolted on with stud bolts. There were a great many staybolts used in the construction, spaced 5 inches on the side sheets and 4½ inches on the crown.

When it was necessary to move the boiler skids were used. This boiler could never stand the usage that either the Tifft or Nunday boiler could stand on account of the narrow water space which filled up with mud when the boiler was in service. There was a 4-inch space between the tube sheet and throat sheet, but that did not help it any. I have been told the drillers could not sink a single well without some repairs being done to the boiler in order to put it in serviceable condition.

Springfield, Ill. John Cook.



Type of Oil Field Boiler Used in the Old Days

Can the Scotch Boiler Be Improved?

(Continued from page 95)

to it during a two years' cruise around the world.

The above particulars were obtained from the chief engineer at various times when the vessel happened to be at New York, from which it would appear that, among other advantages, owing to the rapid circulation and the constancy of its direction, practically all parts of the boiler are at the same, or nearly the same, temperature.

BUSINESS NOTES

C. A. Dunn, formerly sales representative of The Prime Manufacturing Company, has been appointed manager of sales of The Weldless Tube Company, Wooster, Ohio.

The Gibb Instrument Company, Bay City, Mich., manufacturers of electric welding equipment, has opened a sales office in Cleveland, Ohio, at 2104 East Superior avenue, in charge of W. O. Little.

The Combustion Engineering Corporation, Ltd., and the Uehling Instrument Company have recently entered into an agreement whereby Uehling interests in the Dominon of Canada and Newfoundland will be handled exclusively by the Combustion Engineering Corporation, Ltd., with principal offices located in Toronto, Montreal, Winnipeg and Vancouver. The Uehling line includes such fuel economy equipment as CO_2 recorders, SO_2 recorders, draft recorders, combined barometer and vacuum recorders, absolute pressure indicators, etc.

Joseph T. Ryerson & Son, Inc., with main plant and offices in Chicago, has purchased the plant, stock and good will of the Cincinnati Iron & Steel Company, Cincinnati, Ohio. The Ryerson Company will now have six steel service plants, located at Chicago, St. Louis, Detroit, Buffalo, New York and Cincinnati. The plant of the Cincinnati Iron & Steel Company occupies a full city block at Front and Freemont streets, with about 110,000 feet of floor space. Lewis E. Skinner, who is well known in steel circles, through his 18 years with the Ryerson Company, now has charge of the plant. Mr. Skinner will be assisted by C. A. Parnell, former assistant to Arthur Allshul, at the Ryerson Buffalo plant.

OBITUARY

Thomas T. Parker, who for many years was connected with the Fidelity & Casualty Company in their home office, died at his home in Chicago on March 28. Ill health compelled that he relinquish his activities for the last three years. After making what was thought a gallant effort to regain his health he suffered a sudden stroke of paralysis about three weeks before his death.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

Vice-Chairman—D. S. Jacobus, New York.

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

Annual Meeting—The Homestead, Hot Springs, Va., June 4, 5 and 6.

President—A. G. Pratt, Babcock & Wilcox Company, New York.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Frank, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Boiler Makers' Supply Men's Association

Annual Convention—Hotel Tuller, Detroit, Mich., May 22 to 25.

President—W. M. Wilson, Flannery Bolt Company, Pittsburgh, Pa. Vice-President—George R. Boyce, A. M. Castle Company, Chicago, Ill. Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

Master Boiler Makers' Association

Annual convention—Hotel Tuller, Detroit, Mich, May 22 to 25.

President—Thomas Lewis, G. B. I., L. V. System, Sayre, Pa.

First Vice-President—E. W. Young, G. B. I., C. M. & St. P. R. R., 81 Caledonia Place, Dubuque, Iowa.

Second Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry St., Bloomington, Ill.

Third Vice-President—Thomas F. Powers, System G. F. Boiler Dept., C. & N. W. R. R., 1129 Clarence Ave., Oak Park, Ill.

Fourth Vice-President—John F. Raps, G. B. I., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.

Fifth Vice-President—W. J. Murphy, G. F. B. M., Penn R. R. Lines West, Fort Wayne Shops, Allegheny, Pa.

Secretary—Harry D. Vought, 26 Cortlandt St., New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Ave., Columbus, Ohio.

Executive Board—L. M. Stewart, G. B. I., Atlantic Coast Lines, Waycross, Ga., Chairman.

TRADE PUBLICATIONS

Welding and Cutting Apparatus.—The Alexander Milburn Company, Baltimore, Md., has recently issued catalogue No. 1122 illustrating its line of welding and cutting apparatus. A price list is also included.

Welding and Cutting Apparatus.—A piece parts catalogue of 15 pages has recently been issued by the Torchweld Equipment Company, Chicago, in which is illustrated and listed a complete line of welding and cutting torches and their parts, gas pressure regulators and gages.

Miscellaneous Equipment.—The Western Tool & Manufacturing Company, Springfield, Ohio, has issued catalogue No. 19 illustrating its line of expanding mandrels, tool holders, lathe dogs, C clamps, shop furniture, emery wheel dressers, and vises. Prices also are given.

Zeolite Water Softeners.—Water softeners in which zeolite is used to remove every trace of lime and magnesia are described in Bulletin 509 recently issued by the Graver Corporation, East Chicago, Ind. The chemistry of Zeolite water softening is described as well as the details of operation of the Graver Zeolite softener.

Oxy-Acetylene Outfits.—The Air Reduction Sales Company, New York, has issued two booklets describing and illustrating its line of oxy-acetylene welding and cutting apparatus and equipment, together with its tube welding machines and acetylene generators. The bulletins devote some attention to the history of these subjects, and the use of equipment.

Ingersoll-Rand Products.—A condensed catalogue of the products manufactured by the Ingersoll-Rand Company, New York, with a special index feature has recently been sent out. In the space available complete data on all products was impossible so the company requests that readers send in requests for individual bulletins where desired. Particular attention is called to the engineering data section devoted to information of value in solving pneumatic problems.

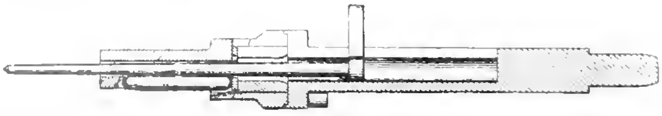
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,447,154. TUBE EXPANDER. WILLIAM F. SAWADSKI, OF CHARLESTON, SOUTH CAROLINA.

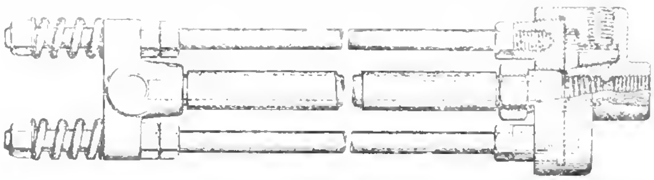
Claim 1. In a tube expander, a stock having a bore therein, elongated slots whose opposed side walls are rounded inwardly and which provide pockets thereby, expansion rollers freely seated in the pockets, a conical pin movable longitudinally in the bore for contacting with the rollers and projecting the



same, said stock having an elongated slot therein arranged between the inner terminal of the bore and inwardly of the rollers, and the longitudinal walls provided by the slot being arranged at opposed angles, and a substantially V-shaped head on the widened end of the pin projecting through the slot and whose angle side surfaces of which are designed to frictionally engage with either of the angle walls provided by the slot, when the stock is revolved, as and for the purpose set forth.

1,448,530. AUTOMATIC CUT-OFF FOR FUEL OF OIL-BURNING BOILERS. PERRY H. GENTZEL, OF NEWTON, MASSACHUSETTS.

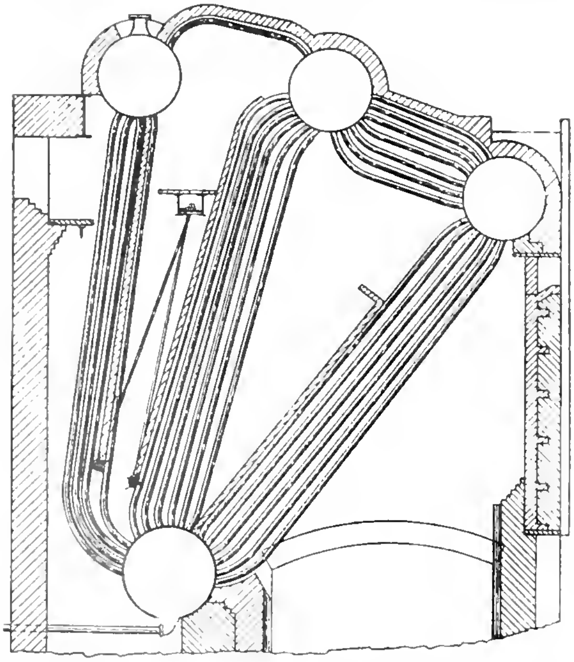
Claim 1. A device for automatically cutting off the flow of fuel of an oil-burning boiler when the water reaches a predetermined level in the boiler, consisting of a frame, a head carried by said frame and formed with ports for connection with the oil supply and with the burner, said ports being arranged to normally communicate with each other, a diaphragm mounted over



the end of one of said ports, a spring for normally holding said diaphragm away from said end to maintain communication between said ports, an expansible tube mounted beneath said diaphragm and arranged to support and operate the same and a connection from said tube to the boiler at a predetermined low water level therein, whereby when said level is reached steam will enter said tube and expand the same and operate to force said diaphragm against the end of the port and close the fuel passage way to the burner, substantially as set forth. Three claims.

1,447,443. BAFFLE SUPPORT FOR WATERTUBE BOILERS. WILLIAM J. STOOP, OF WHEELING, WEST VIRGINIA.

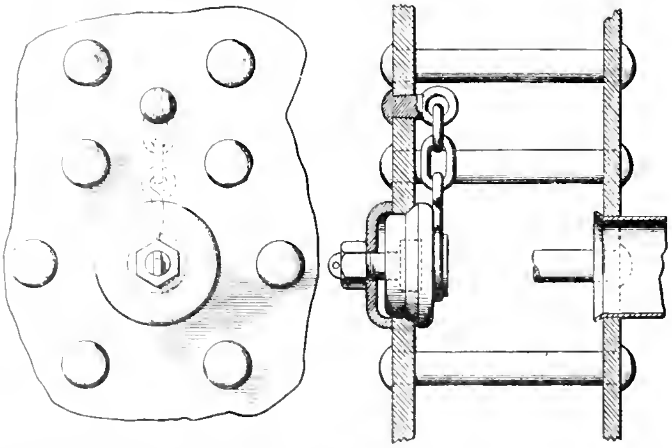
Claim 1. In a watertube boiler the combination with an inclined baffle for guiding and deflecting the products of combustion with respect to the banks of watertubes, of a mounting for said baffle comprising a horizontally



disposed pipe arranged in underlying supporting relation to the lower end of of said baffle, said pipe having its ends opening outward through the side walls of the boiler, and suspension rods by which said pipe is carried, said rods being attached to a stationary supporting member occupying an elevated position within the boiler. Three claims.

1,446,812. SAFETY BOILER PLUG AND METHOD OF INSTALLING SAME. GEORGE A. SAGER, OF ALBANY, NEW YORK.

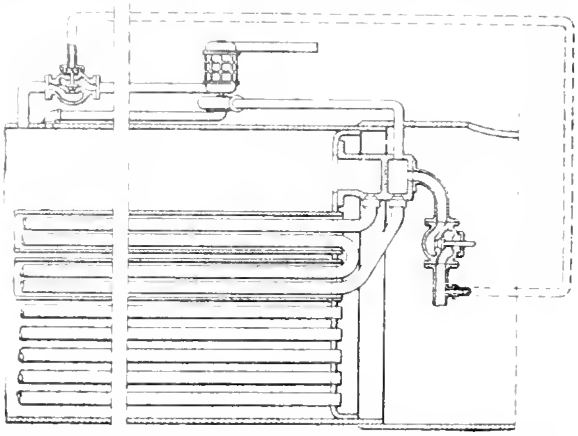
Claim 1. The combination with a boiler sheet having a tapered opening therethrough and being provided with a second opening, of a plug closing the



first opening from the inner side of the sheet, an anchoring member having a tapered shank fitting through said opening from the inner side of said sheet, and connecting means between said member and the plug. Four claims.

1,449,228. LOCOMOTIVE BOILER. SEIGO HASEGAWA AND TAKASHI IKEGI, OF OSAKA, JAPAN.

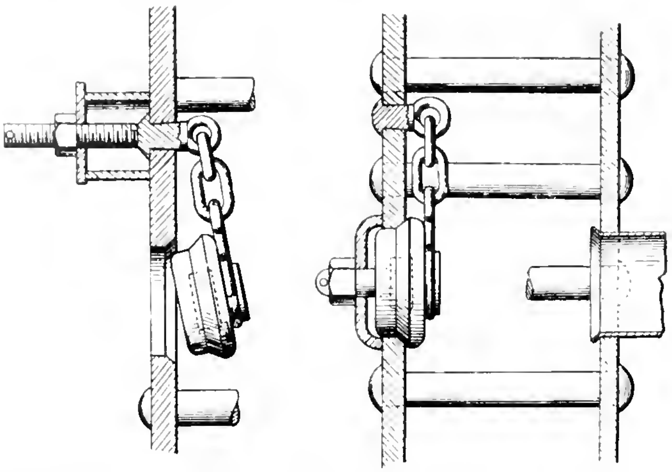
Claim 1. The combination with a boiler having a superheater provided at its receiving end with a saturated steam header and at its discharge end with a superheated steam header, of valve controlled means for supplying steam



from said superheated steam header to steam consuming means, means connecting the discharge and receiving ends of said superheater, and means in said connecting means for causing a positive circulation of steam through said superheater when the supply to said steam consuming means is shut off. Seven claims.

1,446,813. METHOD OF INSTALLING SAFETY BOILER PLUGS. GEORGE A. SAGER, OF ALBANY, NEW YORK.

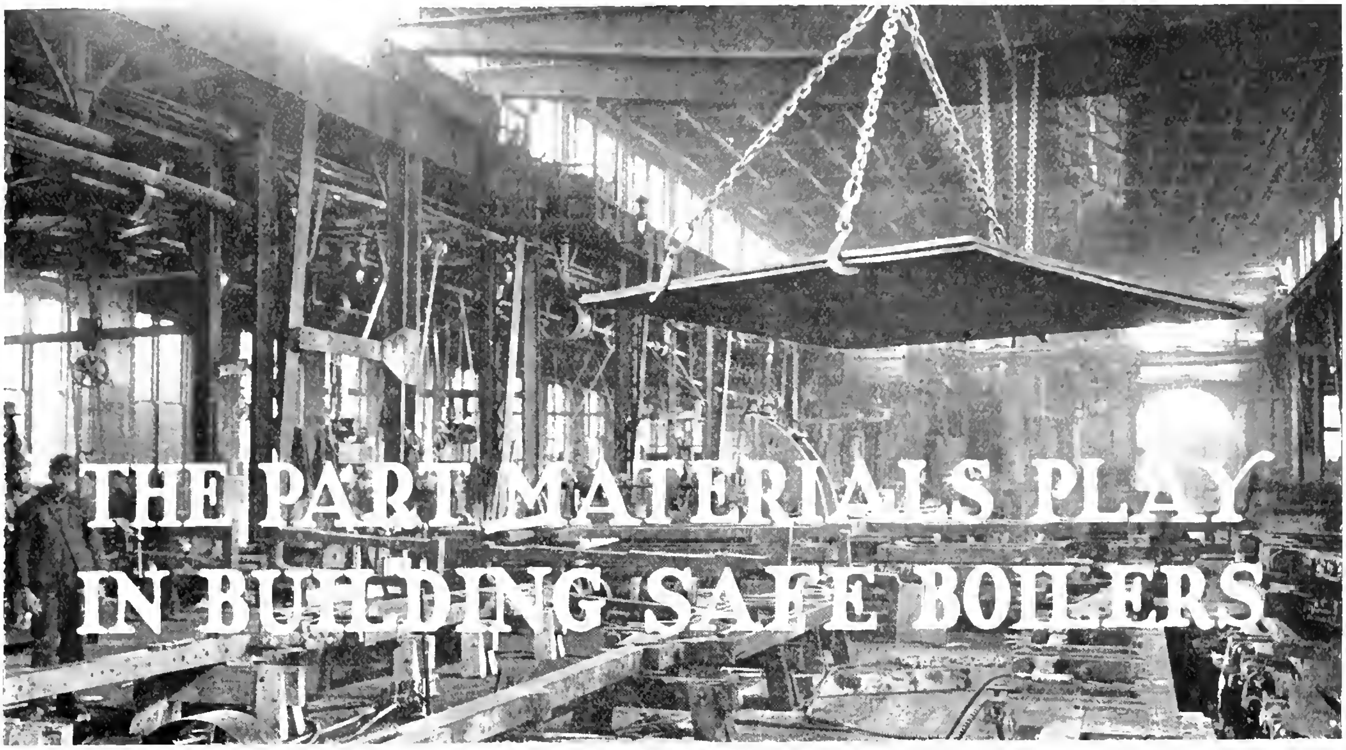
Claim 1.—The method of installing a plug upon a boiler sheet which consists in fitting an attached anchoring bolt for the plug through the sheet



from the inner side thereof, drawing the bolt outwardly into wedging engagement with the sheet, and securing the bolt against inward retraction through the sheet. Four claims.

THE BOILER MAKER

MAY, 1923



> Locomotive boiler design and construction are advancing—bigger boilers, higher pressures, the extensive development of economizing devices are all working toward higher efficiency. Are materials keeping pace with this development? The answer of course is that they are, but how many realize the rigid requirements to which boiler materials are manufactured and the steps taken by the mills and the locomotive builders to insure that these standards of development are maintained. The purpose of the following article is to briefly outline certain modes of procedure established to bring about a freedom from defects of both chemical and physical origin in material entering the fabrication of a locomotive boiler.

THE safety of a locomotive boiler begins and ends with the materials of which it is constructed. Three factors enter the development of a locomotive and of its boiler — design, materials and workmanship. Of the three, materials is probably least understood by the men in the shops; that is, the methods employed by the steel mills and in the laboratories of the railroads themselves to insure that the best of material for a given purpose is used and the standards of the mill or road are maintained.

The methods employed by one of the greatest locomotive building concerns in the world have been used as the basis for the following details of specification, test and inspection procedure which over a long period of time have proven their value in supplying a large proportion of the motive power of the United States and, in fact, a considerable part of the locomotive tonnage of the world.

HIGH STANDARDS NECESSARY

The great need of industry today is standardization and the locomotive industry is no exception to the general rule. Standards of design, materials and fabrication are all necessary and, in spite of the fact that in many instances acceptable standards are already available, they are not utilized to their greatest advantage.

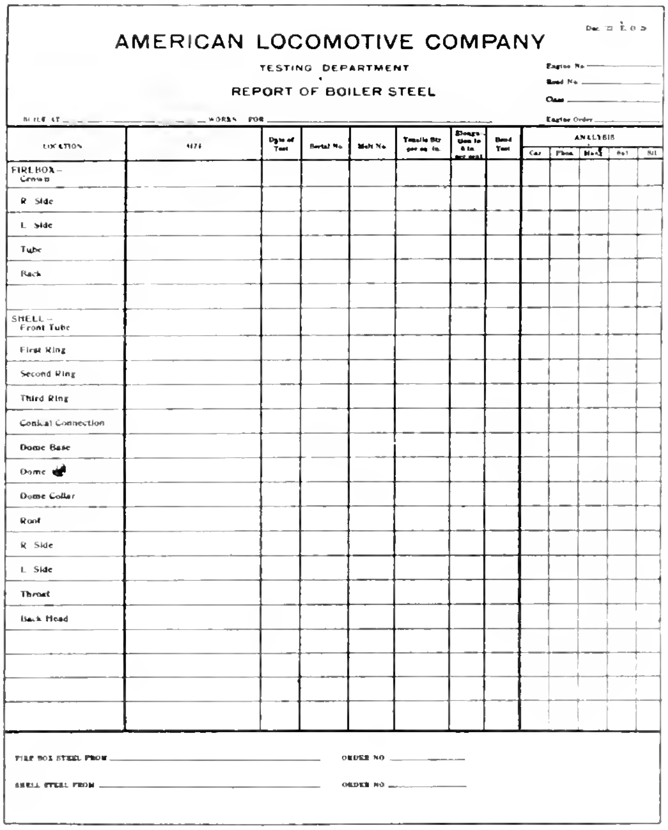
The locomotive builders referred to above, realizing the value of well developed standards in the matter of material, have, in effect, adopted as their own the standards promulgated by the American Society of Testing Materials.

The steel mills work in very close conjunction with the Locomotive Works in the matter of material and the greatest dependability can be placed on them to furnish materials in strict accordance with specification requirements. Details will first be given of the procedure followed in handling ma-

*The information and illustrations used in the preparation of this article were made possible by the courtesy of the American Locomotive Company, Schenectady, N. Y.

terials made strictly to Locomotive Works specifications. When material is supplied to the Works on a railroad company order the methods of inspection and checking are varied somewhat.

In each of the steel mills supplying material, company inspectors are located who follow plates, bars, tubes, flues and other supplies through the work, checking the serial numbers, heats, order numbers and the like on records which are sent to the home plant. On company work, material is manufactured to requirements for a specific locomotive and the records are maintained accordingly. On arrival at the plant, the plates, or whatever the material may be, are applied to that particular locomotive and to no other. The steel companies are required to indicate on their bills the locomotive



AMERICAN LOCOMOTIVE COMPANY

TESTING DEPARTMENT

REPORT OF BOILER STEEL

Engine No. ______
Bond No. ______
Class ______
Engine Order ______

BUILT AT ______ WORKS FOR ______

Location	Size	Date of Test	Serial No.	Melt No.	Tensile Str. per sq. in.	Elongation in 8 in. per cent	Bend Test	Analysis: Car.	Phos.	Man.	Sul.	Sil.
FIREBOX—Crown												
R. Side												
L. Side												
Tube												
Back												
SHELL—Front Tube												
First Ring												
Second Ring												
Third Ring												
Conical Connection												
Dome Base												
Dome												
Dome Collar												
Roof												
R. Side												
L. Side												
Throat												
Back Head												

FIRE BOX STEEL FROM ______ ORDER NO. ______

SHELL STEEL FROM ______ ORDER NO. ______

Fig. 1.—Chart for Recording Tests on Boiler Materials

number for given material order and this is checked in the material storage yard against the order upon its arrival. A later section of this article will be devoted to details of the storage yard and the inspections made here before the material is put into production.

Specifications for Material

In brief, the steel mills are required to supply two classes of steel for boilers—flange and firebox—each made by the open-hearth process. The chemical composition of the steel is given in Table 1.

A ladle analysis of each melt of steel is made by the manufacturer to determine the percentages of the chemical elements of which it is composed, the sample being in the form of a test ingot made during the pouring. A report of the composition is supplied to the Works. A check analysis is also sometimes made from a broken tension test specimen from the plate itself.

It must be possible to bend a test specimen cold through 180 degrees without cracking on the outside of the bent portion. For material one inch or under in thickness the specimen is bent around a pin, the diameter of which is equal

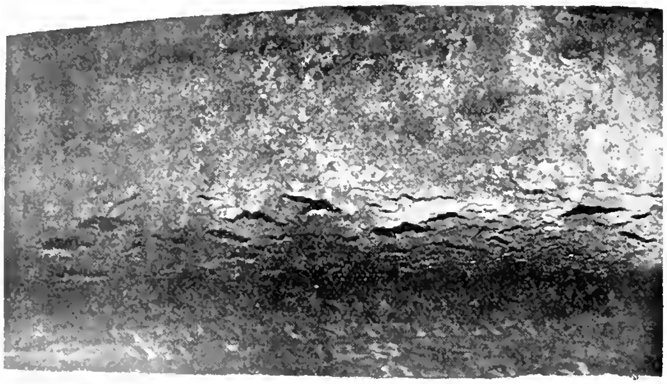


Fig. 2.—Test Specimen Taken from Burned Firebox Sheet

to the thickness of the specimen while for material over one inch in thickness it is bent around a pin of a diameter equal to twice the thickness of the specimen.

In the case of firebox steel a sample is taken from a broken tension test specimen to determine the homogeneity of the

Table 1—Chemical Composition of Boiler Steel

		Flange	*Firebox*
Carbon	for plates ¾ in. or under in thickness	... ...	0.12–0.25 percent
	for plates over ¾ in. in thickness	.. ....	0.12–0.30 percent
Manganese	for plates ¾ in or under in thickness	0.30–0.60	0.30–0.50 percent
	for plates over ¾ in. in thickness	0.30–0.60	0.30–0.60 percent
Phosphorus	Acid, not over.	0.05 not over	0.04 percent
	Basic, not over.	0.04 not over	0.035 percent
Sulphur, not over	....	0.05 not over	0.04 percent

material. This sample must not show a single seam or cavity more than ¼ inch long in either of the three fractures obtained in the test for homogeneity, which are made as follows: The specimen is either nicked with a chisel or grooved on a machine transversely about 1/16 inch deep in three places approximately 2 inches apart. The first groove is made 2 inches from the square end and each succeeding groove is made on the opposite side from the preceding one. Specimens are then firmly held in a vise with the first groove about ¼ inch above the jaws, the projecting end is then broken off by light blows of a hammer, the bending

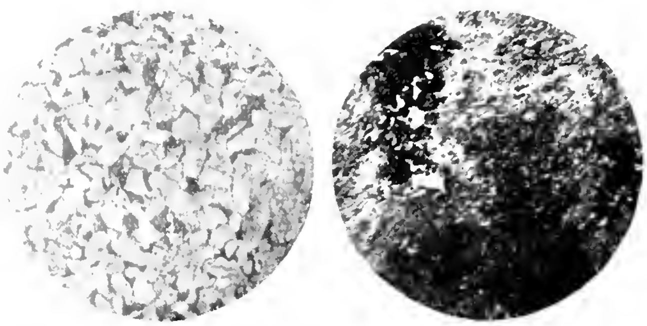


Fig. 3.—Photomicrographs of Burned Sheet. Specimen from Unburned Section (Left), Burned Plate at Right

being made away from the groove. The specimen is broken at the other two grooves in the same manner. As can be readily understood, the object of this test is to open up and render visible any seams due to failure to weld up or due to interposed foreign matter or any cavities caused by gas bubbles in the ingot. One side of each fracture is examined and the lengths of the seams and cavities determined, the inspector using a pocket lens if necessary.

Table 2—Tensile Properties of Boiler Steel

	Flange	*Firebox*
Tensile strength, lbs. per sq. in...	55,000–65,000	52,000–62,000
Yield point, min................	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min. percent..	1,500,000 / Tens. str.	1,500,000 / Tens. str.

NOTE: For material over ¾ inch in thickness a deduction from the percentages of elongation specified above of 0.125 percent is made for each increase of 1/32 inch of the specified thickness above ¾ inch.
For material ¼ inch or under in thickness the elongation is measured at a gage length of 24 times the thickness of the specimen.

The specimens used in making tension tests are taken longitudinally from the bottom of the finished rolled material while the bend test specimens are taken transversely from the middle of the top of the finished rolled material. Longitudinal test specimens are cut in the direction of the longitudinal axis of the ingot and the transverse specimens at right angles to the axis.

A tension and bend test are made from each plate as rolled. If any test specimen shows defects of machining or develops flaws it is discarded and another specimen substituted.

Certain limits are allowed in the specification requirements; for example, the thickness of plate has an upper limit of .01 inch greater than that ordered but must not exceed this allowance above or below the thickness. All plates of each width and group thickness constituting a lot in a shipment must not exceed the amount of overweight given in Table 3. In this table one cubic inch of rolled steel is assumed to equal 0.2833 pound.

When material is furnished the manufacturer's brand or name, melt or slab number, class and lowest tensile strength for the class specified is legibly stamped on each plate. Test specimens are also stamped with the melt or slab number. Sometimes it is specified in the order that the plates must be match-marked so that the test specimens representing them can be readily identified. When more than one plate is sheared from a single slab or ingot each one should be match-marked so that all of them may be identified with their respective test specimens. The match-mark consists of two overlapping circles each not less than 1½ inches in diameter placed upon the shear lines and made by separate impress of a single circle steel die. Match-mark coupons are required to match with the sheets represented and only those which match properly are acceptable.

Any material showing injurious defects subsequent to its acceptance by the manufacturer's works is open to rejection and the manufacturer notified of this.

Steel Plates for Tank and Miscellaneous Uses

Two grades of steel are required for special tank work made by the open-hearth process. In both cases the sulphur contained must not exceed 0.06 percent. The difference in quality is recognized in the method of testing. Certain plates over 3/16 inch thick are subjected to a bending test in which test pieces are cut from the plates after the shear edge is removed by grinding or machining. These specimens are required to bend over a mandrel whose diameter is over one and a half times the thickness of the plate without sign of fracture. The other plates covered in this section are 3/16 inch and under and are not required to meet the above bending test. In the case of the plates tested, two pieces 12 inches long and 1½ inches wide are furnished for each melt or for every twenty plates ordered. The plates must be true to size, flat, free from buckles and surface defects and must not vary from the thickness ordered by more than 0.01 inch. All plates have the engine order number, size, scale, weight and similar data painted on in white lead.

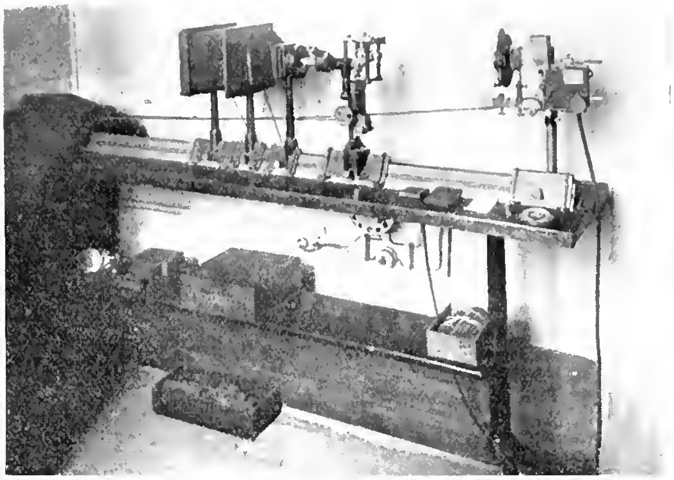


Fig. 4.—Apparatus for Making Photomicrographs of Material

Flues, Safe Ends and Arch Tubes

The tubes used by this company are made from knobbled hammered charcoal iron. The tests made on tubes and flues

Table 3—Permissible Overweights of Plates Ordered to Thickness

Ordered Thickness, In.	Permissible excess in average weights per square foot of plates for widths given, expressed in percentages of nominal weights: Under 48 in.	48 to 60 in. Excl.	60 to 72 in. Excl.	72 to 84 in. Excl.	84 to 96 in. Excl.	96 to 108 in. Excl.	108 to 120 in. Excl.	120 to 132 in. Excl.	132 in. or Over	Ordered Thickness, In.
Under ⅛	9	10	12	14	..	..	..	..	..	Under ⅛
⅛ to 3/16 excl.	8	9	10	12	..	..	..	..	..	⅛ to 3/16 excl.
3/16 to ¼ excl.	7	8	9	10	12	..	..	..	..	3/16 to ¼ excl.
¼ to 5/16 excl.	6	7	8	9	10	12	14	16	19	¼ to 5/16 excl.
5/16 to ⅜ excl.	5	6	7	8	9	10	12	14	17	5/16 to ⅜ excl.
⅜ to 7/16 excl	4.5	5	6	7	8	9	10	12	15	⅜ to 7/16 excl.
7/16 to ½ excl.	4	4.5	5	6	7	8	9	10	13	7/16 to ½ excl.
½ to ⅝ excl	3.5	4	4.5	5	6	7	8	9	11	½ to ⅝ excl.
⅝ to ¾ excl.	3	3.5	4	4.5	5	6	7	8	9	⅝ to ¾ excl.
¾ to 1 excl.	2.5	3	3.5	4	4.5	5	6	7	8	¾ to 1 excl.
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

are quite interesting and extensive. They come under the head of quench bend tests in which strips ½ inch in width by 6 inches in length are planed lengthwise from tubes, heated to a cherry red and quenched at once in water, the temperature of which is 80 degrees F. This test specimen must be able to bend in opposite directions at each end without showing cracks or flaws. Nick bend tests are also made on strips ½ inch in width by 6 inches in length planed lengthwise in tubes. These specimens when nicked by light hammer blows are required to show a wholly fibrous fracture. Expansion tests are also made. In this case a test specimen 12 inches in length is used which is heated to a length of 5 inches to a bright cherry red (1,200 to 1,400 degrees F.), placed in a vertical position and a smooth taper steel pin at blue heat (600 to 800 degrees F.) forced into the end of the tube by pressure or by light blows of a 10-pound hammer. In this test the tubes are required to expand to one and one-eighth times their original diameter without splitting or cracking. The pin is of tool steel tapered 1½-inch per foot of length. A specimen 2½ inches in length is used in the crushing test.

Tubes 10 B. W. G. or lighter are required to withstand crushing longitudinally without splitting or cracking or bending at the weld to a height of 1⅛ inches. If heavier than 10 B. W. G. they must withstand the test to a height of 1¾ inches.

Tubes under 5 inches in diameter are subjected to an internal hydrostatic pressure of 1,000 pounds per square inch and tubes 5 inches or over in diameter are given a hydrostatic pressure of 800 pounds per square inch, provided that the fiber stress does not exceed 16,000 pounds per square inch. In the latter case the following formula is used to determine the test pressure:

$$P = \frac{32{,}000\ t}{D}$$

in which: P = the pressure in pounds per square inch.
t = the thickness of the weld in inches.
D = the inside diameter of the tube in inches.

If the quality of the material is in doubt a cross section of the tube is ground to a perfectly true surface, polished free from dirt or cracks and etched until the soft parts are sufficiently dissolved for the iron tube to show a decided ridged surface with the weld distinctly indicated. A steel tube would show a homogeneous surface. Physical tests are made on each of two tubes taken from a lot of 250 or less. The name of the manufacturer, the words "knobbled charcoal" and the test pressure in pounds are legibly stenciled on each tube. When tubes are inserted in the boiler they must stand expanding and beading without splitting or breaking.

Lap Welded and Seamless Steel Boiler Tubes

Lap welded and seamless steel boiler tubes, boiler flues, superheater flues, safe ends and arch tubes for the Works are all made from steel manufactured by the open-hearth process. The steel is required to conform to the following chemical composition:

Carbon	0.08–0.18	percent
Manganese	0.30–0.60	percent
Phosphorus, not over	0.04	percent
Sulphur, not over	0.045	percent

Test specimens taken from tubes 6 inches or under in diameter and having a thickness less than 9 percent of the outside diameter are required to be flanged at right angles to the body of the tube without showing cracks or flaws. This flange as measured from the outside diameter of the tube must not be less than 15 percent of the outside diameter but the flange in no case should exceed ½ inch in width. For all tubes except tubes in superheater pipes on which the flange test is not required a test specimen 3 inches in length must stand flattening between parallel plates until the distance between the plates is not over three times the wall thickness without showing cracks or flaws. Test specimens 2½ inches in length taken from tubes (except superheater flues) are required to stand crushing longitudinally until the outside folds are in contact without showing cracks or flaws. Similar test specimens from superheater flues should withstand crushing longitudinally down to 1¼ inches without showing cracks or flaws. The hydrostatic tests in this case are similar to those made on lap welded charcoal iron tubes.

Tubes for company work must stand expanding and beading without showing cracks or flaws or opening at the weld. Superheater flues properly manipulated should have the necessary forging, welding and bending operations made without developing any defects.

Boiler Rivet Steel

Boiler rivet steel is made by the open-hearth process and is required to conform to the following chemical composition:

Manganese	0.30–0.50	percent
Phosphorus, not over	0.04	percent
Sulphur, not over	0.045	percent

A ladle analysis is made of each melt of steel to check the chemical composition.

Tension tests are made from test specimens on bars which must have the following requirements as to tensile properties:

Tensile strength, pounds per square inch	45,000–55,000
Yield point, min	0.5 tens. str.
Elongation in 8 in. min. percent	1,500,000 / Tens. str.

Cold bend tests and quench bend tests are made on test specimens. The diameter of each bar must not vary more than 0.01 inch from that specified. The above requirements are for rivet steel in bar lengths. Slightly different requirements exist for rivets. Tests are made on the rivet shank which must be able to bend cold through 180 degrees flat on itself without cracking on the outside of the bent portion. The rivet head must flatten while hot to a diameter two and one-half times the diameter of the shank. One tension test is made on each size of each lot of rivets offered for inspection and three flattening tests are also required.

Staybolt Iron

Staybolt iron used in the Works is rolled from a bloom, slab pile or box pile made from reworked all-pig puddled iron or reworked knobbled charcoal iron. The puddle mixture and the component parts of the bloom, slab pile or box pile must be free from any admixture of iron scrap or steel. The iron is limited to 0.10 percent of manganese.

It is required to conform to the following tensile properties:

Tensile strength, pounds per square inch (1¼ square inches and under in sectional area)	48,000–52,000
Yield point, pounds per square inch (1¼ square inches and under in sectional area)	0.6 tens. str.
Elongation in 8 inches min. percent	30
Reduction of area, min. percent	48

Etch tests are also made on the iron to indicate whether it was rolled from a bloom, slab pile or box pile and whether or not it is free from steel. Tension tests are made on two bars taken from lots of 100 or less.

Hollow staybolt iron is required to conform to the standards of regular staybolt iron. The tensile tests in this case being as follows:

Tensile strength, pounds per square inch	48,000–52,000
Yield point, min	0.6 tens. str.
Elongation, when measured in 8 inches, min. percent	28
Elongation, when measured in 4 inches, min. percent	35
Reduction of area, min., percent	42

Fig. 5.—Section of Laboratory Used for Making Carbon Determinations in Steel

Fig. 6.—Chemical Apparatus Used in Determining the Sulphur Content of Iron and Steel

In this case, however, additional tests are made by splitting a 2-inch length open from end to end by means of a drift or wedge driven into the hole. The structure thus shown must be free from signs of imperfect welding and the presence of slag or scale in the weld. Bars of one size are sorted into lots of 1,000 linear feet. Two samples are selected from each lot for test. Bars must be smoothly rolled and free from slivers, depressions, seams, crop-ends and evidences of burning, the whole should be as nearly axial and as nearly round as the best manufacturing practice permits and should have an area equivalent to that of a round hole 3/16 inch in diameter. The holes should be free from slag and other obstructions.

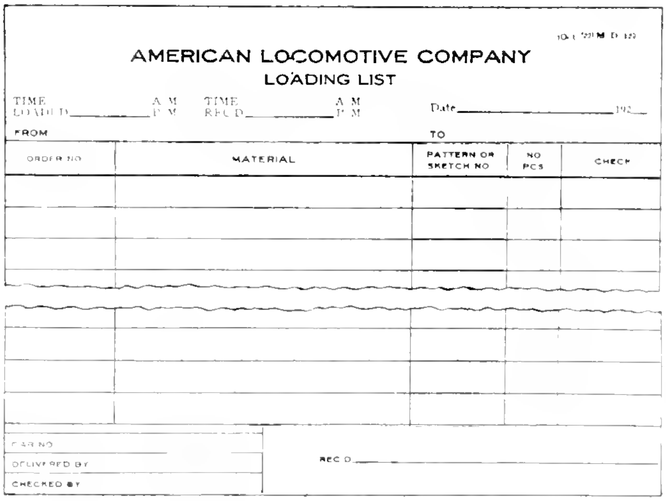
Iron for radial flexible stays and boiler braces is rolled from a bloom, slab pile or box pile, entirely made from puddled pig iron or knobbled charcoal iron. Steel must not be present. Tension tests follow:

Tensile strength, min., pounds per square inch	48,000
Yield point, min., pounds per square inch	0.6 tens. str.
Elongation in 8 inches, min., percent	28
Reduction of area, min., percent	45

Lots of 100 each are the basis for taking test specimens, two bars being used from each lot or fraction of a lot.

Specification Requirements Rigidly Adhered To

The experience of the Locomotive Works has been that the steel mills will furnish material exactly as specified. At various times check tests have been made in the laboratories of the Works to determine the chemical and physical compositions of materials and almost invariably these tests check closely with those of the mills so that it has been found unnecessary on material manufactured to Company specifications to duplicate the mill tests at the works except in very rare cases. The Company inspectors located at the mills maintain complete records of all material and its status in production. They supervise all tests, stamping and work in complete cooperation with the material manufacturers and their inspectors.


AMERICAN LOCOMOTIVE COMPANY
LOADING LIST

TIME LOADED ___ A.M. P.M.	TIME REC'D ___ A.M. P.M.	Date ___ 192__
FROM		TO

ORDER NO.	MATERIAL	PATTERN OR SKETCH NO.	NO. PCS.	CHECK

CAR NO.
DELIVERED BY
CHECKED BY
REC'D

Fig. 7.—Loading Material List Used in Storage Yard

When material is ordered according to railroad company specifications, however, and supplied by the railroad, physical and chemical check tests are made in the laboratories at the Works. These tests are made to determine whether such material conforms to the Company requirements and are based on the regular specifications as outlined above. A staff of inspectors is constantly on the floor of the shop checking material, the heat and serial numbers in order to make sure that material is not used which develops flaws and also to see that the proper material specified for a particular locomotive is used on that locomotive and no other. Fig. 1 shows a testing department report of boiler steel. On this report a complete record of every bit of material entering the fabrication of the boiler can be maintained. Plates overheated in flanging, burnt in welding or developing cracks in working or flaws of any nature are tested in the laboratory to determine whether they are usable or not. In the course of production, the foreman, inspectors and the men themselves are constantly looking for flaws or defects and the material up to the time of completing the boiler is subject to replacement if found defective in any way.

The following example of laboratory procedure will indicate the general method used to determine the properties of material: The specimen of defective boiler plate, shown in Fig. 2 was taken from a firebox throat sheet which had been burnt quite badly. Test specimens were taken from the solid portions of the plate and from the burnt portion to determine the tensile strength and other physical properties and these are given in the table below. The chemical composition was also determined from the specimens taken from the burnt portion of the plate and from the part away from the defect. The photomicrographs shown in Fig. 3 were also made.

Chemical Analysis		*Physical Tests*	
Carbon	0.19	Elastic limit	32,400 pounds
Manganese	0.36	Tensile strength	54,280 pounds
Phosphorus	0.013	Elongation	29.5 percent
Sulphur	0.019	Reduction	57.6 percent
Silicon	trace		

The photomicrographs were magnified 100 diameters, the parts being etched in nital, the objective on the miscroscope being 16 millimeters. The apparatus for making microscopic examination of material is shown in Fig. 4.

The Determination of Chemical Properties of Boiler Metals

The procedure followed in determining the chemical properties of defective plate is exactly the same as that followed in all boiler material tests. The principal impurities in the metals which must be guarded against and those for which the tests are principally made are carbon, sulphur, phosphorus, manganese and silicon. The apparatus used for making the carbon content determination is shown in Fig. 5. Here a sample of steel is placed in a nickel boat lined with alundum (a highly refractory material), and the whole placed in a silicate tube heated to 950 degrees C. by means of electric coils. Oxygen is passed over the steel and the sample fused, the iron forming iron oxide and carbon dioxide. The oxygen mixed with the carbon dioxide is passed over platinized asbestos (to insure the complete oxidation of the carbon) and then passed through a tube containing granulated zinc (to remove sulphur dioxide) and through calcium chloride and potassium pentoxide (to remove water) and then through a bulb containing a sodium hydrate mixture which absorbs carbon dioxide, forming sodium carbonate. This bulb is weighed before and after the absorption and the gain in weight is due to carbon dioxide, which contains 27.27 percent of carbon.

Sulphur Reactions

The apparatus under which the tests for sulphur are made is shown in Fig. 6. In this test a 5 gram sample is placed in a Johnson's sulphur flask and attached to the apparatus shown in the illustration. One hundred cubic centimeters of hydrochloric acid is added. The hydrogen sulphide gas given off in the reaction is absorbed in 60 cubic centimeters of a solution of ammoniacal cadmium chloride diluted with 150 cubic centimenters of water, all contained in a 300 cubic centimeter tall form beaker. After the gas ceases to go over,

(*Continued on page* 148)

Recent Locomotive Boiler Explosion Investigations

Overheating of Crown Sheet Due to Low Water Found To Be Cause of Fatal Boiler Failure

By A. G. Pack*

IN the month of February, two serious locomotive boiler explosions occurred which were carefully investigated by the Bureau of Locomotive Inspection and recently reported upon by the chief inspector. Details of the reports are given herewith.

On February 2, 1923, the boiler of Missouri, Kansas & Texas Railway locomotive 591 exploded resulting in the death of one employee and the very serious injury of two others.

This locomotive left Sedalia, Mo., at 6.20 p. m., February 1, hauling freight train 371, consisting of 20 cars, in charge of engineer Clyde E. Johnson, fireman Louis D. Igo and coal passer Wendal Farmer, and had proceeded to a point about two miles east of Louisburg, Kansas, or a distance of about 90 miles from Sedalia, when at 1.05 a. m. the boiler exploded, resulting in the fatal injury of Engineer Johnson, who died two hours later, and the serious injury of fireman Igo and coal passer Farmer, all of whom were bruised and scalded. Engineer Johnson was found with his feet caught under the cab apron and his body hanging out of right side of the gangway. Fireman Igo was thrown outside of right-of-way fence, a distance of over 25 feet. Location of coal passer Farmer was not ascertainable because he was unable to give any account of the accident, and was found by brakemen wandering along side of train.

Details of Accident

This locomotive was a 2-6-0 type, equipped with extended wagon top boiler, having wide radial stayed firebox of three-piece construction. The force of the explosion tore the boiler from the frame and running gear, hurling it forward for a distance of 184 feet. Parts of the boiler and appurtenances were thrown in various directions. The cab was found about 200 feet back and 60 feet to the right and the air compressor was found 60 feet to the left of point of explosion. The front end door was blown 150 feet ahead and 50 feet to the right, and apparently rolled about 200 feet further after striking the ground.

Construction of Firebox

The firebox was of three-piece construction with riveted seams. The flue sheet was ½ inch thick, while other firebox sheets were ⅜ inch in thickness. The crown sheet was supported by radial stays with body varying from 1 inch to 1⅛ inches in diameter, upset to 1 3/16 inches and 1 5/16 inches in diameter at the ends. The four center rows of radial stays beginning with the fifth transverse row, back of flue sheet, were tapered on lower ends, having a taper of 2 inches in 12 inches. The first four transverse rows were of the expansion stay type. The majority of staybolts were 15/16 inch in diameter, spaced 4 inches by 4 inches..

Examination of Firebox

Investigation disclosed that the crown sheet had been overheated from the flue sheet back to and including the twelfth transverse row of crown stays, and from between the fifth and sixth rows of stays on the right side of center of crown sheet to a similar location on the left side. The crown sheet had pulled away from all radial stays, and the side sheet pulled away from 257 staybolts. The line of low water was approximately 5 inches below the highest part of the crown sheet. The initial rupture of the crown sheet apparently occurred between the fifth and sixth rows of radial stays at the flue sheet on left side of center. The left side sheet tore diagonally down to the mudring. The right side sheet tore diagonally from a point near the flue sheet between the fifth and sixth rows of crown stays to the right of center down to a point in the welded seam of the patch, which was 32 inches above the mudring and approximately 16 inches back of the flue sheet. The tear then followed the welded seam for a distance of 18 inches, then through the side sheet for a distance of 7 inches, then again followed the welded seam back to a point 30 inches from the door sheet seam, and then diagonally up to top of door sheet.

Appurtenances

This locomotive was equipped with one water glass and three gage cocks applied in the boiler backhead. Investigation disclosed that the drain pipe at the bottom of water glass was leaking before the locomotive left Sedalia, and later while attempting to repair the defect the drain pipe was broken off. The water glass cocks were then shut off, thus leaving the enginemen without other means of gaging the water in the boiler than the gage cocks.

Tests of Water Glass and Gage Cocks

Tests were made on locomotive 583, which was of the same class as that involved in this accident, for the purpose of comparing the registration of the water glass with the registration of the gage cocks. For the purpose of illustration an extra gage cock was placed slightly to the left and above the top gage cock and approximately 8 inches above the bottom gage cock. This test disclosed that with 1 inch of water in the water glass and the throttle opened, the additional gage cock showed full water, thus indicating that the water raised and was registered at the backhead at least 8 inches when the throttle was opened and steam rapidly escaping.

Numerous tests previously made by this bureau on different railroads have shown that gage cocks when screwed directly in the boiler backhead showed more water than actually prevails throughout the boiler while the locomotive is being worked hard or steam is rapidly escaping from the boiler. Since this boiler was being operated without the use of the water glass, it might be reasonably assumed that the registration of the gage cocks was misleading.

Some of the other appurtenances were damaged to such an extent that their previous condition prior to the accident could not be determined, while examination of others, which were not damaged, did not disclose a condition which was thought to have a bearing on the accident.

Inspection and Repair Reports

This locomotive received monthly inspection at Parsons, Kansas, on January 19, 1923, or 14 days prior to the accident.

Daily locomotive inspection reports on file at Sedalia, Mo., showing repairs needed, were examined and the following items were reported that may have had a bearing on the accident:

January 26, 1923—"Mudring leaking right front corner."
5:07 A. M. Report approved by Foreman W. J. Brooks, with notation, "OK all but mudring."

*Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C.

January 26, 1923—"Crown bolts leaking."
9:30 A. M. Report approved by Foreman W. C. Riley, without notation, indicating that repairs had been made.

January 26, 1923—"Right front corner mudring leaking."
11:30 A. M. "Crown bolts leaking."
Report approved by Foreman D. Q. Hounihan, without notation, indicating that repairs had been made.

January 27, 1923—"Flues, side sheet and crown bolts leaking in
8:45 A. M. firebox."
"Mudring leaking all around."
"Tighten shoveling sheet and put it under apron."
"Engine leaks steam around both steam chests, is not safe to switch with."
Report approved by Foreman D. Q. Hounihan, without notation, indicating that repairs had been made.

January 31, 1923—"Bore out flues."
3:20 P. M. "Flues and mudring leaking."
"Tighten down shoveling sheet and put it under apron."
"Tighten leaks around both steam chest, this engine is dangerous to switch with."
Report approved by Foreman W. J. Brooks, without notation, indicating repairs had been made.

Daily locomotive inspection reports on file at Parsons, Kansas, showing repairs needed, were examined for the following dates and the following items were found reported that may have had a bearing on the accident:

January 15, 1923—"Examine front end, engine don't steam at all."
"Bore out flues."
"Clean off flue sheet."
Report approved by Foreman Tiler without notation indicating repairs had been made.

January 21, 1923—"Washout boiler."
3:30 A. M. "Bore out flues."
"Mudring leaking in right front corner and both back corners."
"Examine front end, engine will not steam."
Report approved by Foreman Tiler without notation indicating that repairs had been made.

January 24, 1923—"Examine right cylinder head and right valve
11:20 P. M. head."
"Steam leaks so bad, can't tell that the headlight is burning."
"Put a gasket between steam chest and cylinder."
Report approved by Foreman Tiler, without notation, indicating that repairs had been made.

The following communications were found in the files of this carrier, at Sedalia, Mo., which tends to show the condition of the firebox prior to the accident:

"DQH (Day Roundhouse Foreman) 1/29/23.
Calk flues and crown bolts in Engine 591. This Engine has one flue that has pin hole in it about a foot from flue sheet and the Engine has every indication of mud on the crown sheet. This Engine ought to be held and the crown sheet bumped with heavy air hammer to loosen the scale and then properly washed or we are going to have trouble with this Engine. I want you to know the condition the Engine came to us in.

(Signed) W. J. Brooks
(Night Roundhouse Foreman)"

Sedalia, 1/30/23.

"Mr. R. A. Walker,
M. M. Franklin, Mo

Condition engine 591 on arrival Sedalia for service on Holden Division. Machinery is in fair condition. Firebox and flues in poor condition. Crown sheet has 3 mud burnt spots and crown bolts leaking, both side sheets show evidence of mud burn and stay bolt heads have started to pull through sheet. Flues do not look so bad but from the way they leak after being worked must have a good deal of mud in boiler. The mud ring leaks all around and grates and side bars will have to be removed and mud ring caulked. I have washed this engine once but did not do much good. Engine should have firebox gone over with air hammer to loosen mud and a few staybolts renewed where heads are the worst. We have only four engines on high line, and I have no engine to put in place of 591. I can not hold engine and do the work. The condition of this engine is likely to cause failure any time.
(Signed) D. Q. Hounihan"

Investigation disclosed that on January 22, 1923, engineer W. H. Neeley was called to run this locomotive out of Parsons, Kansas, at 7 p. m., and that after reaching the locomotive he refused to take it out until repairs had been made, stating that crown sheet, side sheet and mudring were leaking. It being necessary to remove the fire in order to make repairs, the crew was released at 9.40 p. m.

On January 25, engineer Neeley was again called to take this locomotive out of Parsons, when upon arriving at the locomotive he was informed by the fireman that only one crown bolt was then leaking. He ran this locomotive from Parsons to Sedalia, Mo., where he was relieved and the locomotive continued on to Franklin, Mo., at which point it was cut out and ordered to return to Sedalia. Engineer Bestgen was called for this trip and before starting noted that crown bolts were leaking and so reported it on regular inspection report, but ran the locomotive to Sedalia without repairs being made. On his arrival at Sedalia, the following report was made:

"Right front corner mud ring leaking. Crown bolts leaking."

On January 26, at 6 p. m., engineer E. G. Voss was called to run this locomotive out of Sedalia to Paola. He completed the round trip to Paola, arriving at Sedalia on January 28, at 8.55 a. m., but dated his inspection report January 27, and reported:

"Flues, side sheets and crown bolts leaking in firebox. Mud ring leaking all around."

He was again called to run this locomotive out of Sedalia at 3.45 p. m., on January 29, arriving at Paola at 10.55 a. m. on the same date. When interviewed, engineer Voss stated that upon his arrival at Paola he wired superintendent S. B. Moore as follows:

"Engine 591 has both side sheets, crown sheet, mud ring and flues leaking and will have to have boilermaker to make repairs before handling train on 370."

He further stated that a boilermaker came to Paola and made repairs and that the locomotive was run from Paola to Sedalia, arriving at Sedalia at 3.20 p. m., January 31, at which time the flues and mudring were reported leaking. This locomotive then remained at Sedalia until the beginning of the trip on which the accident occurred.

Fireman Igo and coal passer Farmer were so badly injured that an interview was not deemed advisable at the time of the investigation. However, fireman Igo has since made a sworn statement with respect to this accident, in which he stated in substance as follows:

"That he was called to leave Sedalia at 5:50 P. M. on February 2, and that upon arrival at locomotive 591, in company with engineer Johnson, they found a small leak around water glass drain pipe. When an attempt was made to inspect the interior of the firebox it was found that due to a large amount of coal having just been put on the fire, he was unable to see the firebox sheets. The right injector was tested and seemed to operate satisfactorily, but afterwards when pulling out of Sedalia and passing the Katy Car Shops, the right injector was inoperative, and although repairs were attempted at different times, they never got it to work.

"The engine was foaming shortly after leaving Sedalia and continued to do so at intervals. While at Brysons, which is 16 miles from Sedalia, the fire had burned down so that they could see the crown sheet, and it was noted that water was falling on the fire in the front end of the firebox. He and engineer Johnson looked at the crown sheet and saw a mass of small leaks around the crown bolt heads, some of the leaks being large enough that water was dripping and others so small that the water was just boiling out from the bolt heads. There were also quite a few leaks around the side sheet bolts. Mr. Johnson remarked to him that if he had had a chance to inspect this firebox before leaving Sedalia he would not have operated the locomotive and that he (Igo) felt the same way about it.

"At Holden which is 49 miles from Sedalia, they found the leaks were somewhat worse, especially the larger ones, as water was now running down, instead of dripping. The water foamed several times between Holden and Gunn City Tank, and engineer Johnson remarked that he didn't like this very much, on account of the condition of the firebox. At Freeman Tank, which is about 79 miles from Sedalia, the sheets were leaking worse than ever, and after engineer Johnson had looked at the crown sheet and side sheets for possibly four or five minutes, he got up slowly and said 'Igo, I don't like the looks of that firebox a bit, take a look and see what you think of it.' They left Freeman and had reached a heavy grade near Louisburg, Kansas, when the accident occurred."

Summary

While it is evident from the lines of demarcation on the crown sheet that this accident was primarily due to the failure of the crown sheet because of having been overheated, due to low water, it is apparent that the condition of this firebox, as ascertained by the frequent reports and statements herein referred to, covering the leaky and defective conditions thereof, and the absence of suitable means for registering the general water level in the boiler under all conditions of service, were strong contributory causes for the failure, and evidences a fact that this locomotive was not in proper condition and safe to operate without unnecessary peril to life or limb, as anticipated by the law.

A Second Disastrous Explosion

On February 16, a stud blew out of the boiler of Erie Railroad locomotive 3024, resulting in the injury of three employees. This locomotive left Jersey City, N. J., at 10.45 p. m. in charge of engineer E. J. Murphy and fireman H. J. Spears, and had reached a point near Highland Mills, N. Y., or approximately 49 miles from Jersey City, when, at 1.30 a. m., a stud applied in the boiler to support the running board bracket blew out resulting in the injury of engineer Murphy, fireman Spears and brakeman Brigham.

This stud was located on the left side of the boiler near the cab floor and directly in front of the cab door, and when blown out forced the jacket back against the cab which in turn deflected the escaping steam and scalding water into the cab and upon the men therein.

Examination of Stud

This stud was 7/8 inch in diameter with 12 threads per inch on that portion which screwed into the boiler. The stud fitted so that it could be screwed all of the way in without the aid of a tool, although threads in the sheet were in good condition and those on the stud slightly worn. That portion of the stud on which the running board bracket rested was badly worn, indicating that the bracket was loose on boiler and working, which was confirmed by the loose condition of the cab and brackets at the time of our investigation, also by the daily inspection reports later referred to.

Daily inspection reports on file at Port Jervis, N. Y., and Secaucus, N. J., were examined for the following dates and there were reported the following items which have a bearing on this accident:

Port Jervis, N. Y.
February 4, 1923.
"Staybolt leaking in left side of cab. Cab fastened to boiler."
February 7, 1923.
"Cab bolted fast very loose."
February 11, 1923.
"Staybolts leaking under jacket in front of cab left side."
Secaucus, N. J.
February 7, 1923.
"Cab very loose, left side."
February 15, 1923, 3:20 P. M.
"Staybolts on left side of cab under jacket leaking bad. Fills cab full of steam."

Investigation disclosed that there was no evidence of broken staybolts in the left side sheet, nor of any leakage from staybolts from which it is apparent that the leaks reported were coming from the stud which later blew out.

When interviewed, the master mechanic stated with reference to the daily inspection report of the engineer on February 15, at 3.20 p. m. "That the boiler inspector made an inspection of the left side sheet in the vicinity described by the engineer, and failed to find any broken or leaky staybolts, but did find a stud leaking. This he reported to the roundhouse foreman, who in turn inspected the stud and stated that he did not consider it bad enough to remove."

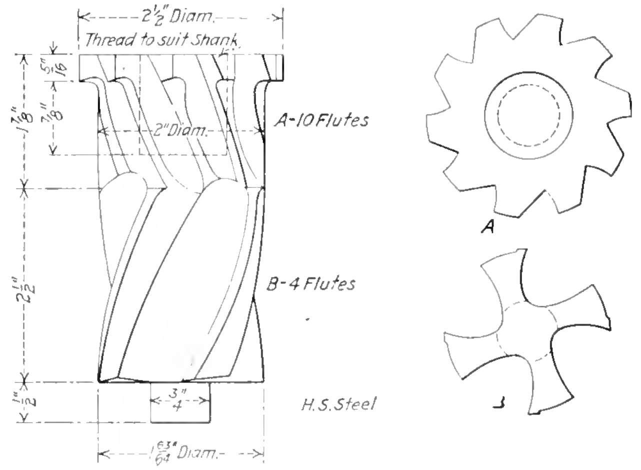
It is evident that this accident was due to the improper fit of the stud and to failure to make necessary repairs to the defective stud, which had been the cause of numerous reports and which was contributed to by the loose condition of the cab, and had the requirements of the law and rules been complied with this accident would have been avoided.

Cutting and Reaming Tube Sheet Holes

By George Bexton*

For rapid and smooth cutting of boiler tube sheet holes, the combination cutter and reamer illustrated has been found very satisfactory. It reduces costs and speeds up the work. Previous to the development of this tool cutting was done in two operations. All the tube holes were cut out to within 1/64 inch of the size required, by a tool similar to the cutter illustrated at *B*. Then the tool was changed to a reamer similar to *A*. This made it necessary to set each hole twice, whereas by combining *A* and *B* in one tool the job could be done in one operation. Cutter *B* is fed by the machine until it has cut through the plate, the feed being released and reamer *A* finishing the job, being fed by hand since this is quicker than machine feed.

The tool, illustrated, is made of Double Mushet high-



Combination Cutter and Reamer Saves Time on Tube Sheet Holes

speed steel. Cutting section *B* has 4 flutes with a spiral of 1 inch in 12 inches right-hand, giving the cutter a rapid cutting action. The reaming section *A* is cut 10 flutes, left-hand spiral to prevent the reamer from seizing and leaving a rough hole. The reamer has a recess 1/4 inch wide and 1/16 inch deep between *A* and *B* to allow any cuttings to escape from the cutting section. Section *A* has a taper of 3 inches in 12 inches for a distance of 7/16 inch and then paralleled cutting edges 7/8 inch long to finish the hole to the correct size. A round filleted shoulder at the top removes the sharp edges of the tube sheet holes and prevents the copper ferrules from being cut in the process of beading or expanding. The tool is detachable from its spindle, which is turned down to 1 1/16 inch in diameter and threaded 12 threads per inch. This threaded end of the spindle turns into the threaded cavity in the cutter. The use of a heavy oil on the threads enables cutters to be readily removed so that the operator may use any number of cutters on one spindle.

*Tool Foreman, Grand Trunk Shops, Stratford, Ont.

Boiler Inspecting In Australia

By George Cecil

ALTHOUGH Australia's population amounts only to five millions odd, of whom at least a million are descended, directly or indirectly, from the aboriginal blacks, the country decidedly is a progressive one. There are some fourteen thousand manufacturing establishments; railways have long passed their infancy; there is a fair amount of inland river steamer communication; and merchant vessels are forever plying between the coast ports. There are mills in plenty and numerous mines provide their owners with respectable incomes—so respectable that in some countries a super-tax would be imposed on them. Prosperous, in short, is the commonwealth; its machinery imports from the United States and England prove this agreeable state of things—and these imports include boilers.

Boiler Inspection Appointments

They also include boiler inspectors, though not to the same extent as formerly. At one time the imported article was considered a necessity. But of late years Australia has taken too great a pride in her good name to tolerate what she terms "the English interloper." Consequently, Australian-born aspirants rising to the occasion have qualified for these appointments, filling them with credit to everyone concerned. Soon the British variety will, it is hoped, have completely disappeared. "Advance Australia!" is the people's motto, and they live up to it.

The "black fellows," as the natives are called, have no aspirations in this direction. The colored man will act as assistant to the white boiler inspector for a dozen years without taking any interest in the work. He asks nothing better than to receive his pay every Saturday afternoon. The soul of contentment is the native.

Intense Patriotism Shown

The calling is not a highly-paid one, while the pension is but a trifle—scarcely admitting of life's least expensive luxuries. The point, however, is that the Australian by proving his worth, has kept the Englishman out of the field. And this is the wish of every patriotic colonial. All cheerfully admit allegiance to the "mother country," which, by the way, few of them have ever seen, or are likely to see. But, at the same time, it is considered that Australia should be as self-supporting as possible and, to that end, no pains are spared to train men for the position of boiler inspector. Indeed, things have been rather overdone, for if there are not as many inspectors as there are boilers, the country might advantageously do with fewer and increase the salary attached to the post. Meanwhile, the matter is said to be under the consideration of those who have it in their power to improve conditions. These certainly need improving.

Incompetents on the Job

Not so very long ago derelicts and "remittance men" who had drifted out to Australia from England were ready to turn their hands to boiler inspecting. Some, being intelligent, mastered all details and afforded satisfaction; to this day they remain an ornament to the profession. Others, proving hopeless from the very first, had to be gently but firmly shunted. Several half-castes from India, having retired on a pension, also emigrated to the Commonwealth, there to carry on the job to which they had been accustomed for so many years. But their triumph was short-lived. Australia, finding that they already were in receipt of an assured income, quickly sent them packing. Greatly saddened and perhaps wiser than when they left their native land, each had to return to India. The Australian boiler inspecting element rejoiced at the departure of the would-be intruders.

Nor are the homemade half-castes encouraged to oust the colonial of pure blood. Besides, they are not suited to the work, nor, for that matter, to any other sort of employment upon which important issues depend. Boiler inspectors do not even care to utilize them as assistants.

The Rough Road

The Australian is admirably suited to his task, which, in the remote country districts includes roughing it. Upon reaching a point where the railway ends—and there are many such—he may have to ride miles to his destination, mile upon mile without meeting a soul. At nightfall he puts up in a ramshackle inn, tumbledown and dusty, glad to get a plate of cold mutton, a handful of biscuits, and a glass of beer, before turning in between a pair of coarse sheets which probably are none too clean. Sometimes the boiler man drives himself to the mill where his services are required and over an uncommonly rough road, the conveyance being in and out of formidable ruts half the time. As the local highways have long since deprived the cart of its springs, the unhappy driver is dog-tired by sundown. Despite the drawbacks of a ricketty bed, which may not be free from bugs, he welcomes "sleepy time." The most bloodthirsty biters cannot keep the worn out fellow awake.

In the large towns, such as Melbourne, Sydney (the attractive and civilized capital of New South Wales), Ballarat and Bendigo (the famous mining centers), Brisbane, Adelaide and Perth, the car line takes the boiler inspector wherever he wants to go. His life is one of ease compared with that of the man whose duties take him into the provincial wilds. But, whether employed in the town or the country, he always is reliable, doing the job thoroughly and giving an honest report. When examining a boiler which has seen better days, outside considerations do not weigh with him; he is a stranger to graft. Recently, one of the fraternity had to inspect an extremely dilapidated boiler at a small country flour mill owned by his father. The conscientious one unhesitatingly condemned it.

There are, of course, exceptions, when and where are there not? But the black sheep are few; the boiler inspector is almost invariably above suspicion. That is why he dies poor.

DRASTIC MEASURES

As a rule, all repairs can be carried out on the premises and a boiler is soon put in going order. Sometimes, however, the local mechanics find the job beyond their powers, with the result that the steam gage works badly while the stop valve refuses to function. The opening to the manhole, being jammed, the boiler remains long uncleaned; and, for want of new plates, it is a danger to all in the vicinity. The inspection gives the proprietor an uncommonly bad quarter of an hour. "I am," argues the last-named, "over three hundred miles from a town. The cost of new plates is beyond my wretched means. I cannot afford railway freight and cart transport—even if I needed what you consider necessary." But all in vain. The boiler is ordered to be put out of action pending repairs, and the aggrieved machinery user, finding that there is no escaping from the decision, produces the money and all that is necessary is done. Boiler inspectors, as may well be imagined, are not always popular. "They do their duty unpleasantly" is the opinion of those who fail to satisfy them.

When on his provincial rounds, the boiler inspector sees nothing of the light side of life. Except for an occasional kangaroo hunt, the monotony of a singularly drab existence is unrelieved. In the large towns there are the movies and the theater; and the man who wishes to improve his mind is afforded opportunities of doing so. But this is not true in the "bush."

Still, the boiler inspector is satisfied with things as he finds them. Never having known anything better, he is contented. A philosopher.

Report of a British Marine Boiler Explosion

Board of Trade Investigation of Disaster Indicated Low Water as the Cause of Overheating

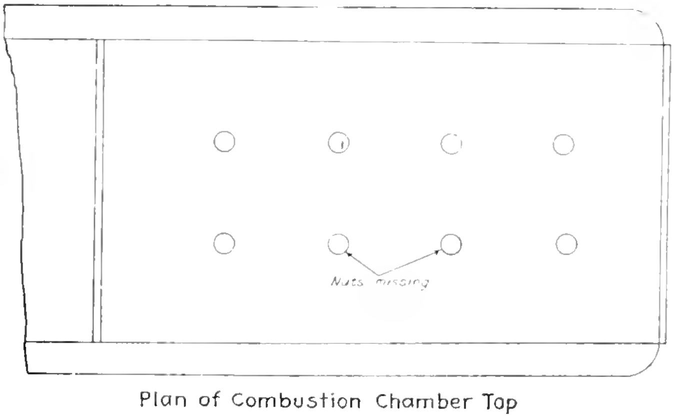
As in this country, it is the custom of government officials to thoroughly investigate all boiler explosions, both marine and railway. The results of such investigations are valuable to all those who design, construct or inspect boilers since reports of this character indicate methods that may be adopted to prevent a recurrence of such disasters.

The British Board of Trade report of the explosion on board the steamship *Kelburne* is given below:

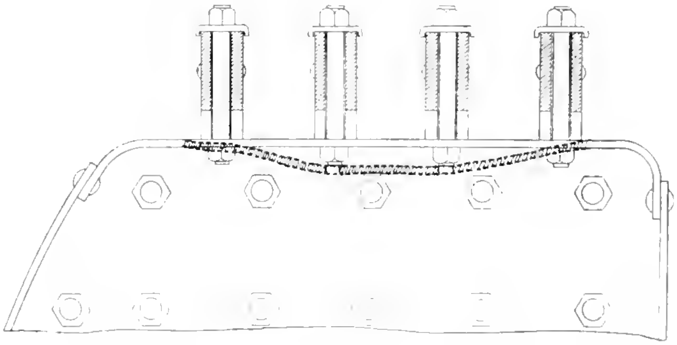
The explosion occurred at about 5:45 P. M. on June 27 last, when the vessel was on a voyage from Birkenhead to Dublin. The vessel is owned by Messrs. J. Gale & Co., Preston. No person was injured in the accident.

DESCRIPTION AND PRINCIPAL DIMENSIONS OF THE BOILER

The boiler is of the single-ended cylindrical multitubular marine type, made of steel, and worked under natural draft at a pressure of 120 pounds per square inch. It is 8 feet 4 inches in length and 9 feet in diameter; the shell is 11/16-inch in thickness, with double butt straps, double riveted. There are two furnaces of the Fox corrugated type, 27 inches in internal diameter, and one combustion chamber to each furnace, stayed at the top by four girders, with two stays to each girder. The usual mountings were provided, including a water gage and two test cocks on the column. The feed arrangement consists of two feed check valves, one in connection with the main engine feed pump and the other with the donkey pump; there being no connection between the two discharge pipes.



Plan of Combustion Chamber Top


Sectional Elevation of Combustion Chamber Top

BOILER OF AN OLD TYPE

The boiler was made by Messrs. Bow, McLachlan & Co., in the year 1904, and is therefore 19 years old. With the exception of the renewal of the furnaces and tubes, in 1919, no repair of importance is recorded.

The boiler was inspected periodically by surveyors to Lloyd's Register of Shipping and inspectors to the Manchester Steam Users' Association, the last survey in each case being held in July, 1921.

NATURE OF THE EXPLOSION

The port combustion chamber top partially collapsed. Two of the stay nuts were carried away, and the plate, being forced off the stays, allowed free escape of steam through the stay holes.

The boiler had been short of water, causing overheating of the combustion chamber top plate, and the overheated plate, in its weakened condition, was unable to withstand the pressure of the steam.

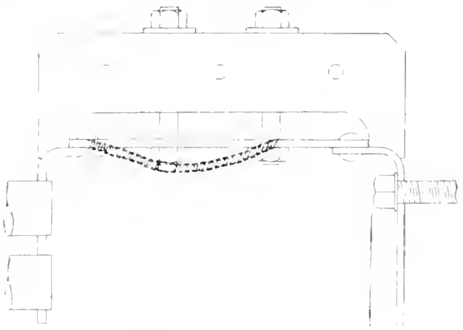
GENERAL REMARKS

The *Kelburne* is a vessel of 199 tons gross, engaged in the coasting trade, and has one boiler which supplies steam to a set of compound engines at a pressure of 120 pounds per square inch.

The boiler and its mountings were surveyed by one of the surveyors to Lloyd's Register of Shipping, in July, 1921, and also by an inspector to the Manchester Steam Users' Association, at the same time, and, according to their reports, everything was in a satisfactory condition.

The vessel left Birkenhead for Dublin on June 26, 1922. On the following day, at 4:30 P. M., the chief engineer relieved the second engineer, the boiler pressure being then 110 pounds per square inch, and it is stated that there were $3\frac{1}{2}$ inches of water showing in the gage glass. At 5:45 P. M. the explosion occurred, and steam, escaping through the stay holes in the combustion chamber top plate, put out the fire in the port furnace. The fire in the starboard furnace was then drawn, and, shortly afterwards, the engines stopped through lack of steam. When the boiler was sufficiently cooled, an examination was made, and it was found that the damage was so serious that the boiler could not be used. The vessel was then taken in tow by the steam trawler *Rose of England* and towed to Dublin.

On further examination, at Dublin, it was found that the combustion chamber top plate was distorted, two stay nuts had been carried away and the plate at these two points



Longitudinal Section of Combustion Chamber Top

Sagged Plate in Combustion Chamber

had been forced over the ends of the stays; other stays in close proximity were badly strained, otherwise the boiler did not appear to have suffered in any way.

A new combustion chamber top was fitted, all the girder stays were renewed, and the tubes expanded. The boiler mountings were found to be in order, with the exception of the main feed check valve chest, which had to be renewed. On completion of the repairs, a hydraulic test was applied, with apparently satisfactory results. Steam was raised, and it was found, after about one hour's steaming, that the tube ends in both combustion chambers were leaking, the leakage gradually becoming worse on the run to Preston. At Preston, the tubes were re-expanded and steam again raised preparatory to leaving that port, when it was found that leakage still took place from the top rows of tubes at both ends.

It appears that, in March of this year, a clip had been fitted around the main feed check valve chest at the fillet of the bottom flange, in order to stop a slight leak that was showing. When this clip was removed at Dublin the chest was found to be cracked for about seven-eighths around the circumference of the inlet branch. A valve seat covering the fracture had at some time been fitted, and the inside of the casting appeared to have been screw-cut, presumably with a view to screwing in a seat. The seat fitted, however, had simply been driven in and pinned. Neither the chief engineer, who joined the vessel three days only before the explosion took place, nor the second engineer had any knowledge as to when the seat was fitted, but as the second engineer states that he saw the clip put on in March last, when he joined the vessel, it may be assumed that the crack had shown at some previous time, subsequent to the survey in July, 1921, and the valve seat had been put in as a precautionary measure.

Both engineers state that, after leaving Birkenhead, a considerable amount of water was being lost through the defective valve chest, necessitating an almost constant supply of extra feed water, although until 4:30 P. M. on the day of the explosion no difficulty had been experienced in maintaining the level in the gage glass. I am therefore of the opinion that the shortness of water was most probably due to a sudden extension of the crack in the chest, causing increased leakage, which was not noticed by the engineer on watch, the result being overheating of the combustion chamber top and consequent failure of the plate. Had both fires been of equal fierceness, no doubt the starboard chamber top would have suffered similarly.

Observations of the Engineer Surveyor in Chief

This explosion was undoubtedly due to overheating consequent upon the boiler being short of water.

The main feed check valve chest was known to be defective and was apparently in such condition as to require the normal feed water supply to be supplemented almost continuously, and it is, therefore, surprising that greater care was not exercised to maintain the water in the boiler at a safe level.

The explosion resulted in the temporary disablement of the vessel, and it is fortunate that assistance was available.

Exhibitors at Master Boiler Makers' Convention

The exhibiting companies of the Boiler Makers' Supply Men's Association will include the following:

Air Reduction Sales Company, New York.
American Arch Company, New York.
American Locomotive Company, New York.
Bird-Archer Company, New York.
The Boiler Maker, New York.
W. L. Brubaker & Bros., Millersburg, Pa.
Burden Iron Company, Troy, N. Y.
A. M. Castle & Company, Chicago, Ill.
Champion Rivet Company, Cleveland, Ohio.
Chicago Pneumatic Tool Company, Chicago, Ill.
Dearborn Chemical Company, Chicago, Ill.
Detroit Seamless Steel Tubes Company, Detroit, Mich.
Ewald Iron Company, Louisville, Ky.
J. Faessler Manufacturing Company, Moberly, Mo.
Flannery Bolt Company, Pittsburgh, Pa.
Forster Paint & Mfg. Company, Winona, Wis.
Garratt-Callahan Company, Chicago, Ill.
Gary Screw & Bolt Company, Gary, Ind.
Globe Seamless Steel Tubes Company, Milwaukee, Wis.
Huron Manufacturing Company, Detroit, Mich.
Independent Pneumatic Tool Company, Chicago, Ill.
Ingersoll-Rand Company, New York.
Key-Bolt Appliance Company, Orchard Park, New York
Liberty Manufacturing Company, Pittsburgh, Pa.
Locomotive Firebox Company, Chicago, Ill.
Lovejoy Tool Company, Chicago, Ill.
Lukens Steel Company, Coatesville, Pa.
McCabe Manufacturing Company, Lawrence, Mass.
Monongahela Tube Company, Pittsburgh, Pa.
National Tube Company, Pittsburgh, Pa.
Otis Steel Company, Cleveland, Ohio.
Oxweld Railroad Service Company, Chicago, Ill.
Parkesburg Iron Company, Parkesburg, Pa.
Penn Iron & Steel Company, Creighton, Pa.
Pittsburgh Forge & Iron Company, Pittsburgh, Pa.
Pittsburgh Steel Products Company, Pittsburgh, Pa.
Prime Manufacturing Company, Milwaukee, Wis.
Rome Iron Mills, Inc., New York.
J. T. Ryerson & Son, Chicago, Ill.
Scully Steel & Iron Company, Chicago, Ill.
S. Severance Manufacturing Company, Glassport, Pa.
The Superheater Company, New York.
Talmadge Manufacturing Company, Cleveland, O.
Thomson Electric Company, Lynn, Mass.
Torchweld Equipment Company, Chicago, Ill.
U. S. Light and Heat Corporation, Niagara Falls, N. Y.

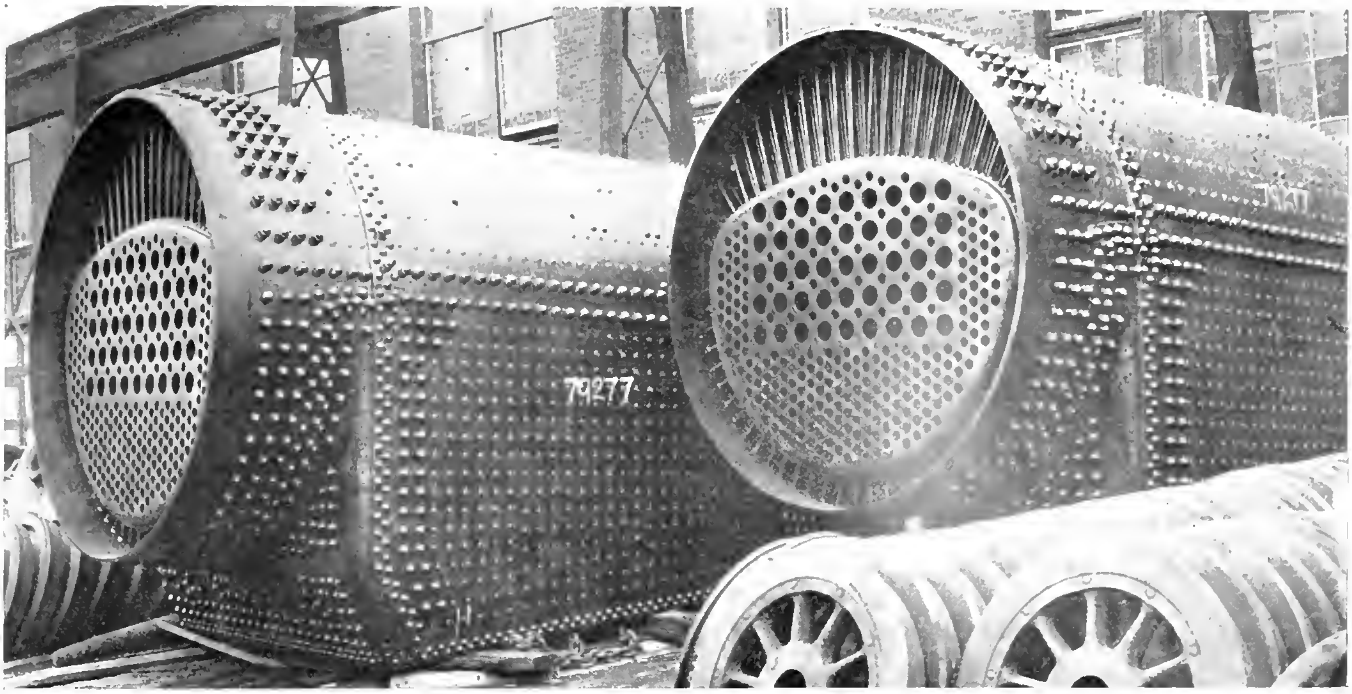


Fig. 1.—Side View of Boiler, Back End, Showing Ball and Sleeve Application in Breakage Zones

New Staybolt Designed to Promote Flexibility

Details of Double Articulated Staybolt Design for Use in Locomotive Boilers

BECAUSE of design features which have been incorporated in a new type "double articulated" staybolt developed by A. F. Pitkin, assistant superintendent of the American Locomotive Company, at the Schenectady Works, the following details of its construction and features are given. The material, tests and information given were prepared by Mr. Pitkin to demonstrate the features of the bolt.

In the days of small locomotive boilers, and therefore short sheets, the "rigid" type of staybolt was satisfactory as the expansion of the sheets was well within the flexible limits of the "rigid" bolt. As the larger boilers were developed increasing difficulty was experienced with the "rigid" bolts breaking near the outer sheet.

Fig. 2.—Result of Weaving Action on Inner Bolt Connections

This was due to the fact that the outer sheet, being the heavier, held the bolt in a rigid vertical position throwing all the strain on the bolt at its junction with the sheet; whereas the inner sheet, being of lighter weight, took up some of the strain by bending, thus to a certain extent relieving part of the flexing strain at the inner "rigid" bolt connection.

By experience, it was found that only certain areas, in the back end, were affected; since called the "breakage zones."

In order to eliminate the failure at the outer connection various types of "semi-flexible" staybolts were introduced in the breakage zones. The development of the "semi-flexible" bolt has resulted in the almost universal use of what is known as the "ball and sleeve" connection.

The adoption of this "semi-flexible" bolt has practically eliminated breakage, at the outer sheet connection, but has failed to relieve the strain at the inner connection so that the injurious action, on this connection and the lighter sheet, is still there.

It is for the purpose of eliminating this condition that the following experiments and recommendations have been developed.

In Fig. 1 is shown a side and back end view of boilers illustrating the ball and sleeve application in the breakage zones.

Fig. 2 illustrates the effect of the continual weaving strain on the inner bolt connection.

The bolt being screwed into the inner, or firebox sheet, increases the mass of metal at these various points so that the heat units are not carried away as rapidly as through the plain sheet. This makes numerous hot points where oxidation will more rapidly take effect.

Even though the bolt may have a tight thread fit in the sheet the continual weaving motion, due to expansion and contraction of the outer and inner sheets, gradually enlarges the connection hole on the water side allowing oxygen in the water to attack the thin metal threads. At the same time minute surface cracks are exposed and assist in the oxidation of the sheet immediately adjacent to the bolt connection.

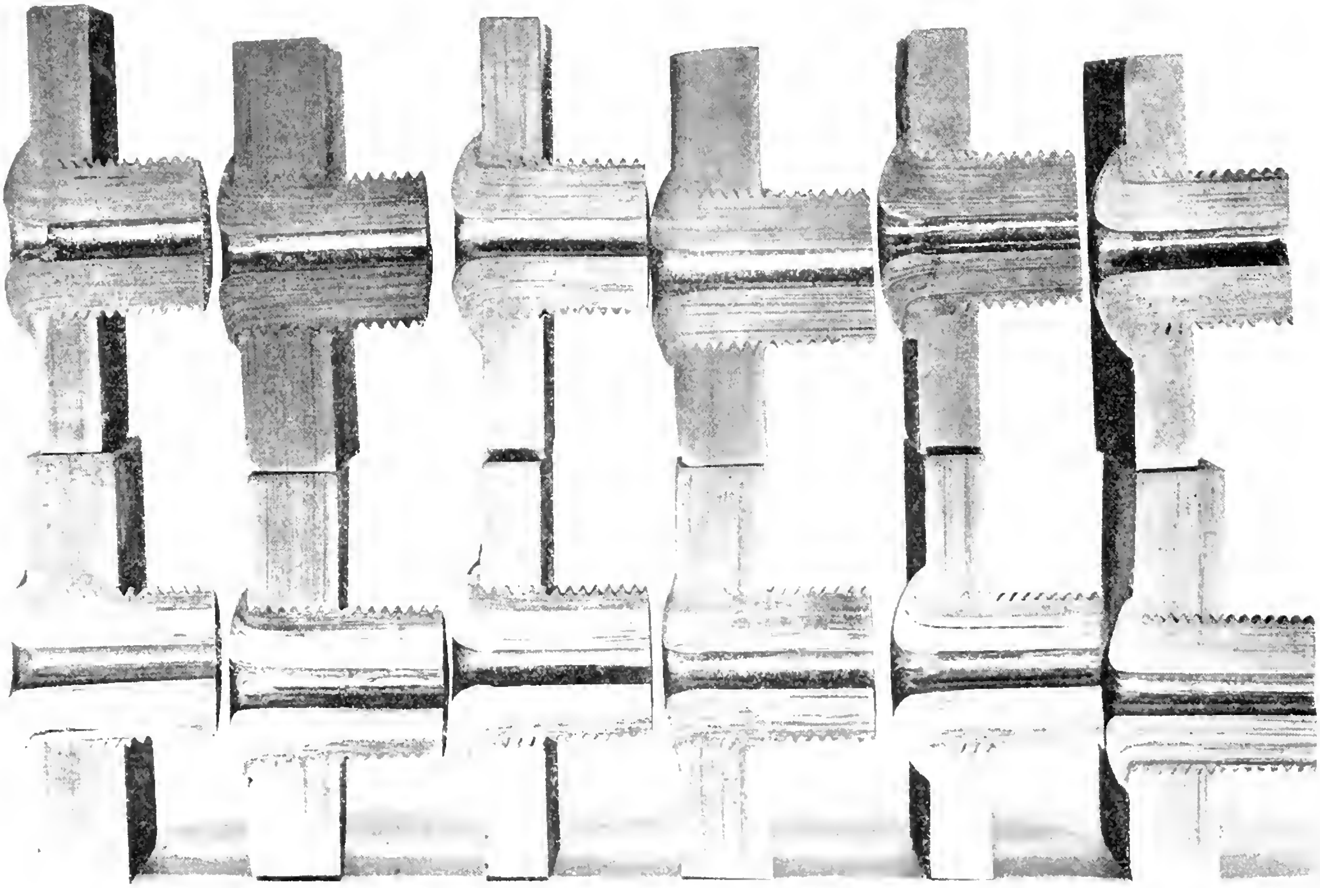


Fig. 3.—Usual Type of Staybolt Connection to Sheet

Lime and other deposits will fill up the enlarged hole and cracks but is broken down by the weaving action, thereby presenting new surfaces for attack. This process continues until it becomes necessary to replace both the sheet and bolts.

The usual form of threaded bolt connection to the sheet is shown in Fig. 3, the end being driven and trimmed from the outside of the sheet.

By examining the etched sections it will be noted that the "upsetting" effect only extends into the threaded connection about one (1) thread, leaving the balance of the threads more or less exposed to the oxidizing effect as illustrated in Fig. 2.

It will be noted that all of these bolts are made of staybolt iron; a material developed on account of its fibrous structure better withstanding the weaving action between the two sheets.

Fig. 4 illustrates two steel staybolt connections—one driven over in the "standard" way showing how the threads remain open at the inner side of the sheet. The other expanded from inside the bolt by first taper-reaming the "tell-tale" hole then driving in a three corner taper pin rotating at the same time and afterward driving and trimming the head.

By this latter method *all* the threads are expanded into the threaded hole, in the sheet, making a tight joint throughout.

It has been found that, due to the fibrous nature of staybolt iron, the pin expanding will split the iron, so with this style of connection steel must be used.

The action of the "semi-flexible" and "double articulated" staybolt on the inner sheet is indicated in Fig. 5.

"A" is a thin sheet of metal, mounted in a wood frame, into which is rigidly fastened the rod "C," representing the "semi-flexible" bolt, and the "double articulated" bolt "B."

Any movement of the outer plate carrying the latter will produce no appreciable effect on the plate "A" while the slightest movement of the rod "C" will produce a bending or warping effect.

As the actual movement between the outer and inner sheets of a boiler is so slight the angular pull on the inner ball connection of the bolt "B" will be practically nil.

By eliminating this weaving effect it is obvious that the fibrous nature of staybolt iron is not essential in its construction. This will make it possible to use steel and the expanded method of connection as illustrated by Fig. 4.

This demonstrates the fact that the present type of bolt is only flexible because the light firebox sheet bends and that this flexibility is gained at the expense of the life of the sheet.

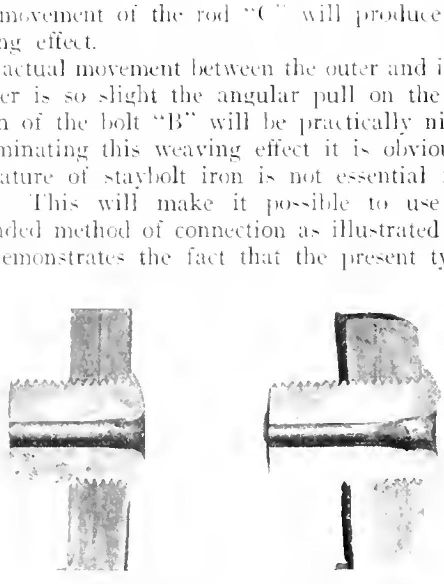


Fig. 4.—Steel Staybolt Driven in Usual Way (Left), that at the Right Expanded in the Side Sheet

The "double articulated" bolt consists of a connection to the outer sheet, which is in the form of a hollow tapered plug, with a tell-tale hole drilled to the ball.

A tell-tale hole is also drilled through the center of inner threaded connection to the ball. The light sections, at these two points, constitute the breaking points.

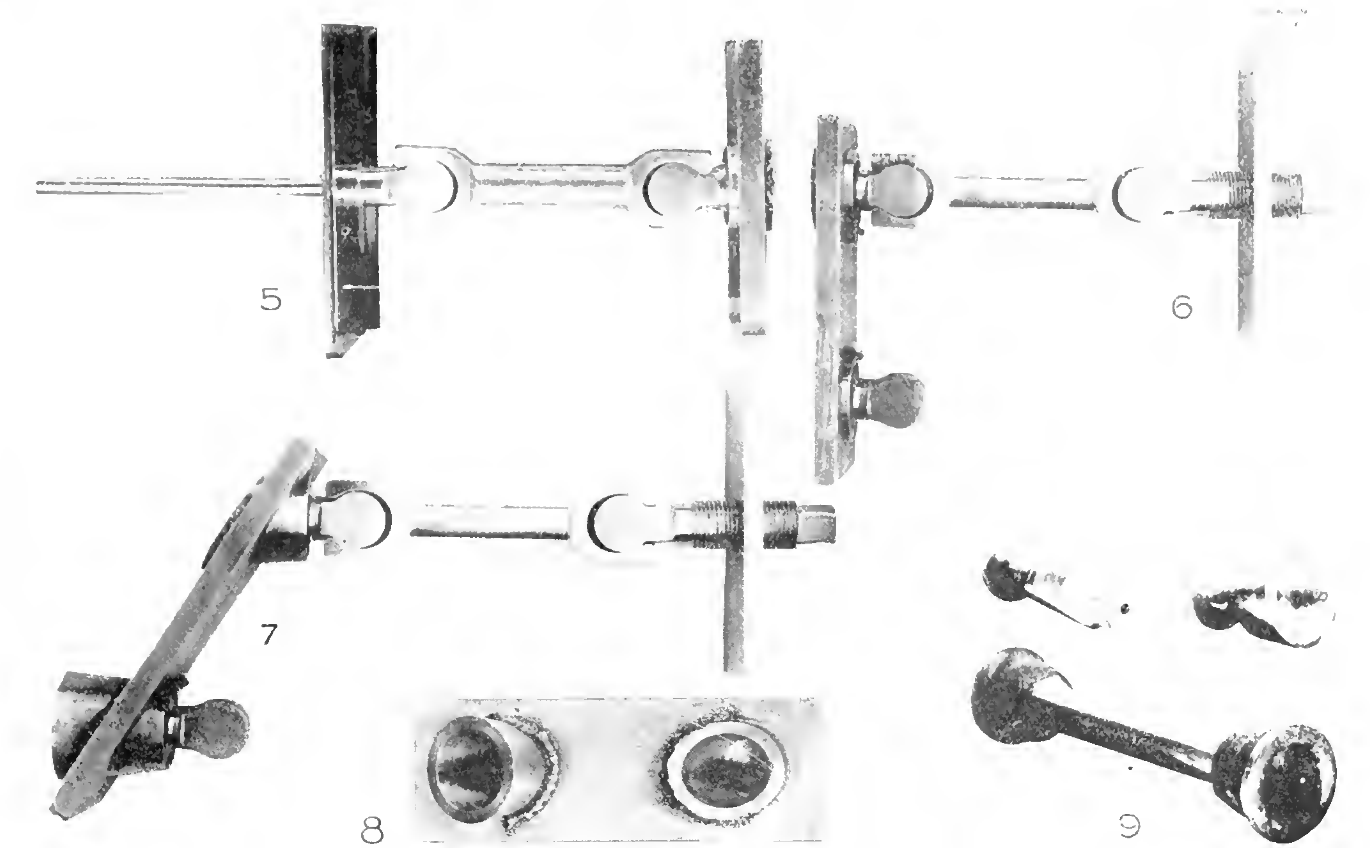


Fig. 5.—Demonstration of Double Articulated Bolt Action. Fig. 6.—Bolt with Standard Plug Connection. Fig. 7.—Staybolt with Hollow Plug Connection Welded to Sloping Sheet. Fig. 8.—Appearance of Plugs Welded. Fig. 9.—Staybolt Parts.

All other sections of the bolt are made considerably stronger, so if, by some remote possibility, a break should occur it would be immediately obvious from outside the boiler or in the firebox.

By making the inner threaded connection of steel the "pin expanded" method of fastening can be used. The hole in the outer sheet is taper reamed, using the hole in the inner sheet as a guide, assuring perfect alinement on application. The taper plug, being welded to the outer sheet, eliminates the expensive operation of tapping with all its attendant troubles of bad threads, leaking and cracked sleeves on the boiler test.

A modified form of bolt has also been developed, so that if desired staybolt iron can be used for the inner connection.

As previously shown, staybolt iron cannot be pin expanded which would make it necessary to drive it over in the regular way. In this form of connection it is desirable to "hold on" the opposite end to prevent stripping the thread.

In order to make "holding on" possible the outer taper plug carries a taper threaded ball connection so that after the bolt is pulled down and plug welded to the outer sheet the outer ball can be screwed down, taking up the expansion spaces in the two sockets, making the bolt temporarily rigid so a "holder on" can be placed at the outer end while the firebox end is driven over.

After the inner connection is made the outer ball is screwed back and the projecting bolt cut off and joint welded.

Fig. 6 illustrates the staybolt with standard plug connection for parallel sheets; also the "flush" type of connection welded to the outer sheet.

Either type, applied under a combustion chamber, it is claimed, will overcome the difficulty experienced with the "semi-flexible," where the sleeve is inverted, making it a convenient receptacle for dirt washing about inside the boiler shell, also eliminating the danger of freezing when the boiler is drained and the engine placed outside in cold weather.

Note the slight projection of the standard welded plug above outer sheet and consequently little interference with the boiler lagging.

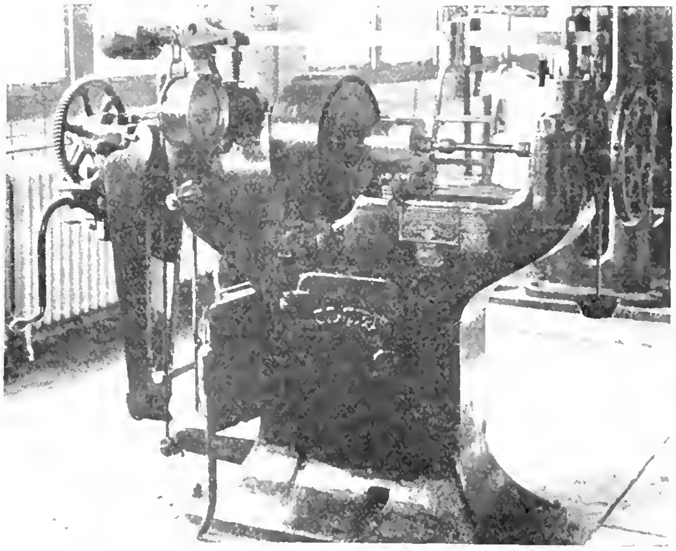


Fig. 10.—Machine Used in Making Vibratory Tests on Staybolts

The staybolt with its hollow plug connection to a sloping

(*Continued on page* 149)

Interior View of British Locomotive Shop

Boiler Design in Relation to Maintenance*

Practices Employed in British Shops in Building and Repairing Locomotive Boilers to Give Maximum Service

By A. E. Kyffin

THE most common British type of firehole is a solid forged ring between the outer and inner firebox plate; this is often the full width of the water space, but sometimes the copper plate is dished to reduce the width of the ring to anything down to about 1¾ inches with the object of shortening the rivets to ensure a tight joint and also of keeping the heads out of the flames; the objection to this practice is that with bad water the scale rapidly collects above the ring and is not easy to wash out. The rivets round a firehole are a constant source of trouble, and to avoid their use various methods are used of flanging both the copper and steel plate to form a ring without any joint. Other constructions are sometimes used to advantage.

Foundation or bottom joint rings are almost invariably of rectangular section of an average width of 3 inches to 4 inches. For boilers having a medium working pressure the riveting can be single, but above 160 pounds double riveting is to be recommended. At the corners the rings are often made with a thinner downward extension to enable either a second or third row of rivets to be worked in according to whether the main portion of the rings is single or double riveted. This method of construction is very expensive, not only as regards the ring itself, but also in the machining of the boiler plates, and if a well-designed corner is used with the plain ring, equally good results can be obtained. The examination of the corners of many fireboxes occasions wonder as to how they keep tight at all, so badly are the rivets pitched, being either too large on the outside to be steam-tight, or the inside copper plate is so cut away by the cluster of rivets that it cannot bed on to the ring. The use of screw rivets should be avoided as far as possible because if once

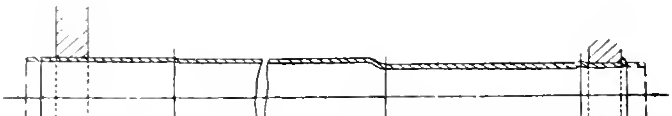


Fig. 10.—Tube Rolled on Water Side of Plate and Beaded on Fire Side

they develop leaks they cannot be laid up again like an ordinary rivet, as this only tends to loosen the thread; and as the squares are always cut off they cannot be screwed up when it is found necessary.

Flanged Plates

The two principal plates are the throat or saddle and the back plate; the former is fairly immune from trouble with the exception of the flat between the shoulders at the top, where cracks sometimes develop, more especially if the joint

*Second installment of a paper read before the Institution of Locomotive Engineers, Manchester, England, November 13, 1922. The first installment appeared on page [illegible] of the April issue.

is only the width necessary for single riveting. Regarding the back plate, an interesting difference of opinion exists as to the best radius for the flanging of the sides; the more usual figure is about 3½ inches inside, but some engineers specify not less than 6 inches. The author has in his recollection a class of boiler which had the back plate flanged with a large radius, and in a comparatively short time it

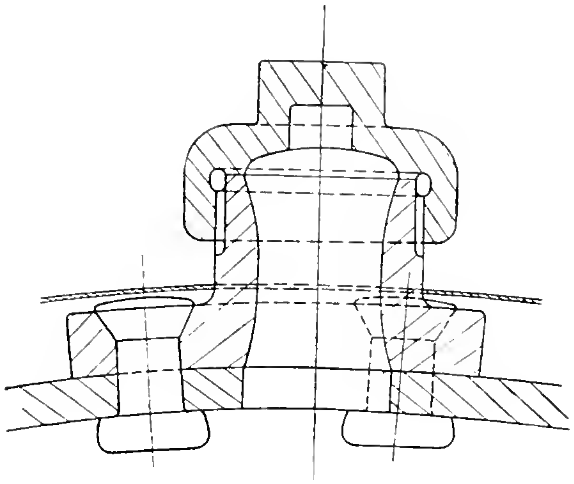


Fig. 11.—Washout Plug with Gun Metal Cap

developed bad cracks at the junction of the radius and the flat of the plate at the upper portion of the firebox; this was attributed to the rigidness of the large radius resisting the breathing of the back, and certainly the trouble disappeared when these plates were replaced with others of less radius.

The form of back plates used on the L. & N. W. Railway and some other lines, in which the flange is reversed in direction from the conventional form, has certain claims made for it, but there are disadvantages also.

There is also a very considerable distance between the line of the riveted joint and the first row of water-space stays; this throws a very heavy stress on the latter and leaves a relatively large unstayed area of steel plate, and even when a few cross stays are put in, experience has shown that long vertical cracks occur. Similar

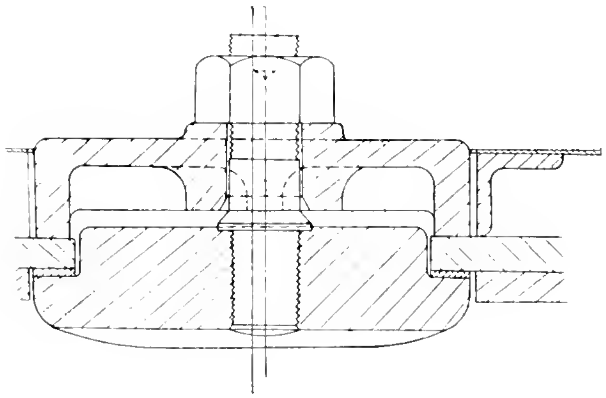


Fig. 13a.—Removable Hand Hole for Access to Firebox Crown

trouble is experienced with the back plate, and generally it would be most instructive to hear from engineers who have to maintain and repair boilers of this type as to how, over a period of years, they compare with the ordinary type back plate.

Tubes

The author does not propose to enter upon the very debatable subject of the material of tubes, but much benefit is to be derived from a discussion regarding the methods of securing tubes in the firebox tube plate. The tubes may be simply rolled into place and slightly bell-mouthed, or they may be beaded right over; or again, they may have a shoulder rolled on them next the water side of the tube plate and beaded on the fire side, as in Fig. 10. The use of ferrules is more

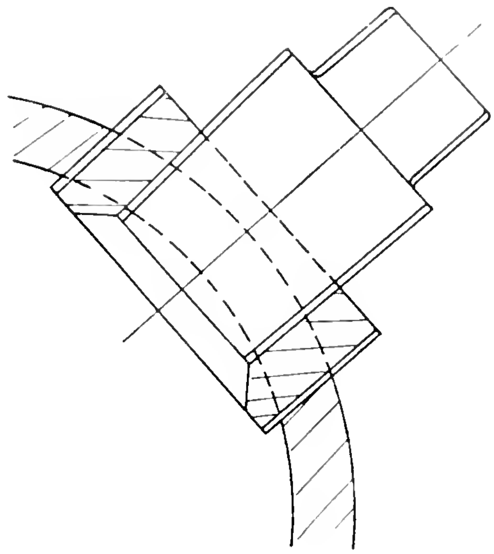


Fig. 12.—A Type of Readily Removable Plug for Washing Out

common with copper and brass tubes than with steel, but there is not apparently any settled practice regarding whether ferrules should or should not be fitted into new boilers whatever be the material of the tubes.

Washout Arrangements

As relatively few railways have good water all over their systems, the provision of ample and convenient washout and

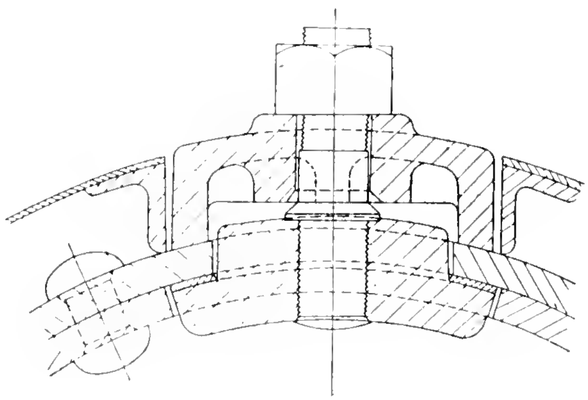


Fig. 13b.—An Adaptation of the Handhole to a Curved Portion of Shell

inspection doors is of the utmost importance, as the cleanness of a boiler has much to do with its active life, not to speak of its steaming qualities.

The average engineer in charge of the running of locomotives usually has to content himself with a few plugs, etc., in the region of the firebox foundation ring, a few in the smokebox tubeplate—often very inaccessible—two or three on the back of the firebox on the line of the firebox crown, and if the boiler has a Belpaire firebox, washouts on the firebox sides. These may, of course, be sufficient, but the provision of extra plugs or capped washouts on the radii of the front and back plate about half-way up, to enable the side water legs of the firebox to be washed out, would be a boon in most cases. Some railways fit a large mud door on the underside of the barrel a little ahead of the firebox so that any scale, etc., washed off the tubes and front end of the barrel may be removed there instead of being washed into the front water-leg of the firebox. Provision is also made for washing the tubes and firebox top from above by fitting capped washouts on the front ring of the barrel and on the firebox crown next the barrel.

Regarding the actual details of washouts, these at the foundation ring are either taper plugs screwed direct into the the steel plate—which is usually thickened by the provision of patch plates—or else into gun-metal seatings; or washouts with screwed capped tops are riveted or screwed on to the corners; the bodies of the latter may be of steel or gun-metal, with gun-metal seatings; or washouts with screwed capped tops are riveted or screwed on to the corners; the bodies of the latter may be of steel or gun-metal, with gun-metal caps on the lines of Fig. 11. The last mentioned practice is not so common on locomotives in use in Great Britain as on those for overseas. With a taper plug screwed direct into the plate it is only possible to get one plug at each

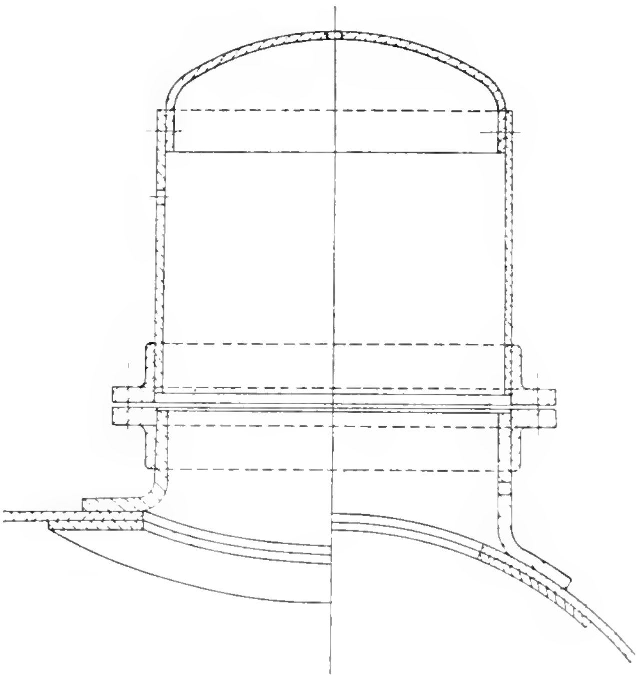


Fig. 14.—Type of Dome Used on British Locomotives Intended for Export

corner of the firebox on the same level, but if seatings are used two plugs at right angles can be provided, while these can easily be arranged with capped washouts, provided, of course, there is room inside the frames. This method has been found entirely satisfactory.

The taper threads in the plates are soon damaged or worn and have frequently to be retapped, and in time become larger than the standard plugs. An interesting scheme for providing readily renewable holes is seen in Fig. 12, consisting of a steel ring screwed with a fine thread into the plate, the taper plug then being screwed into it, with the idea that the ring can be renewed when worn; but whether the remedy is worse than the evil is a debatable point.

The side washouts provided on fireboxes are usually taper plugs, capped washouts or removable handholes, one type of the latter being shown by Fig. 13; the handhole certainly provides the best access to the firebox top. These washouts are commonly located just above the line of the firebox crown, but are sometimes placed on the shoulders of the firebox to enable the stream of water to be directed downwards on to the firebox crown.

Steam Domes

As these house the regulator and are the only means of getting to the main steam pipe, they are of great importance to the running shed force, yet on how many boilers are they of the type in which the joint line of the top is either above the regulator head or only just level with it. The type of dome now most used on engines built in this country for overseas lines is shown in Fig. 14 with this. When the upper portion is removed, the regulator head is so exposed that it can be easily refaced or otherwise attended to; also the main steam pipe joint is fairly accessible, especially if the dome is, say, 2 feet 3 inches or 2 feet 6 inches inside diameter.

A leaking dome joint is always a nuisance and gives rise to considerable work; yet railway men do not seem to have decided whether the joint is best made by a copper ring of the continuous turned variety or the so-called boiled oil joint.

There are other important details of the boiler which, it may be claimed, have been ignored, but the author's excuse must be that the paper is not intended to be even moderately comprehensive, but he hopes that these somewhat disjointed notes will serve the purpose for which they are intended, namely, the gathering together of the experiences and opinions of the members of this institution regarding the features in question.

Steam Boilers in India

Word has just been received that late in January the Legislative Assembly, in India, passed a new bill, amending the laws relating to the construction and operation of steam boilers and providing a single law that will apply throughout the entire country. Copies are not yet available here, but have been requested. Manufacturers and exporters shipping steam boilers to India should be careful to see that they comply with these new requirements, in order that there should be no disappointment at destination upon delivery.

As previously stated, the Bureau of Foreign and Domestic Commerce of the United States endeavors to maintain a complete collection of the steam boiler laws for all foreign countries, and interested parties can ordinarily secure needed information by communicating with the Industrial Machinery Division.

The Problem of Handling Materials With Safety

Safe Practices Pamphlet No. 54 entitled, "Handling Material," has just been published by the National Safety Council, 168 North Michigan avenue, Chicago. Handling material is generally recognized as one of the greatest safety problems in industry, and according to state reports handling material by hand causes more accidents than all machinery. The pamphlet is divided into the following main divisions: Power Trucks, Hand Trucks, Piling Material, Handling by Hand and Safe Habits of Work, each of which is again subdivided into paragraphs dealing with the different types of equipment used and the different methods employed in handling various types of material. The pamphlet is freely illustrated with photographs and diagrams. A large number of industries are covered, and owing to the fact that handling material is common to every industry, the pamphlet has an unusually wide range of usefulness. The experience of many members of the National Safety Council was contributed in the preparation of the pamphlet and the assistance of a committee of seventy-five safety engineers was employed in preparing the material.

Southern Pacific Boiler Shop at Bay Shore

Machinery and Layout of Small Locomotive Boiler Repair Plant Designed for Efficiency

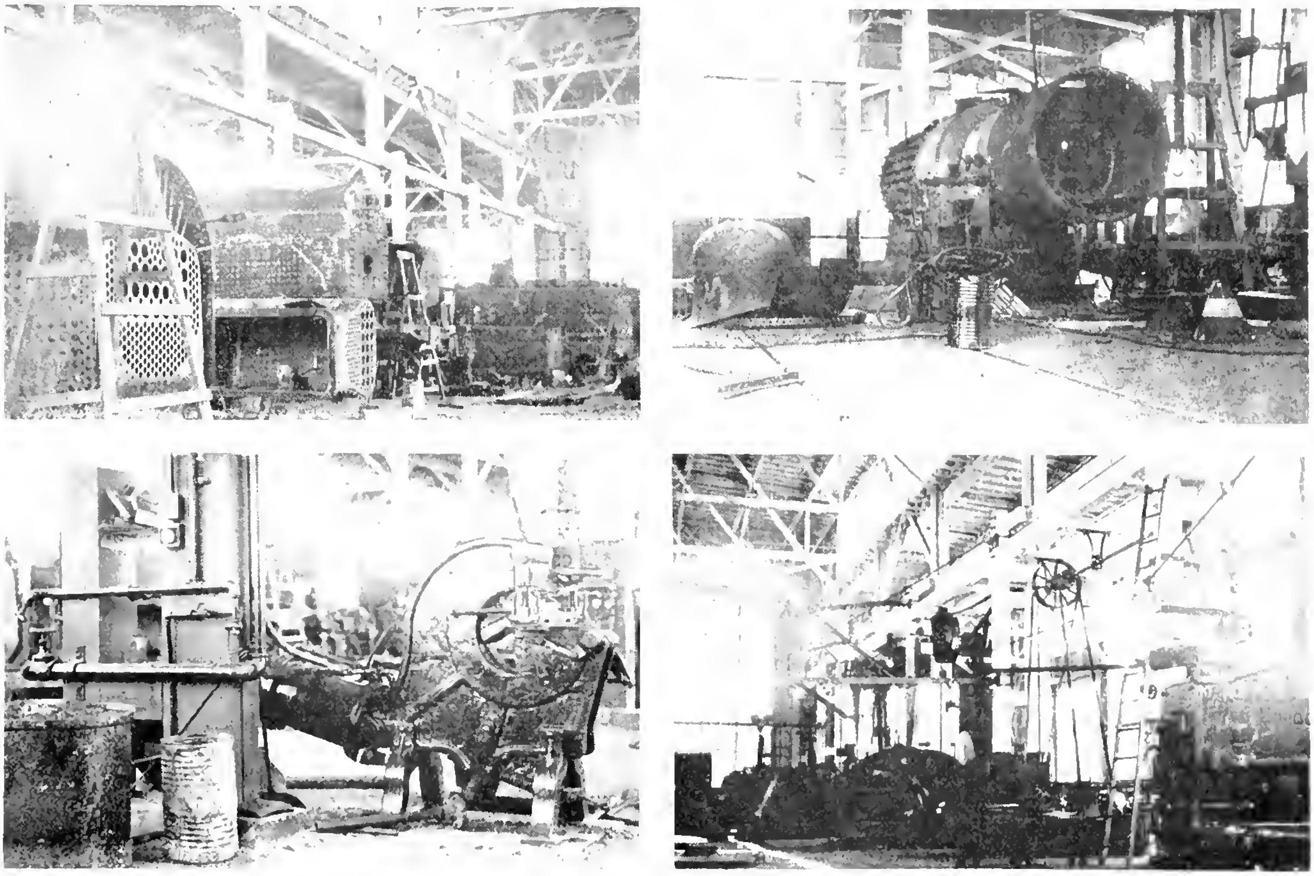
By Charles W. Geiger

THE boiler shop at the Bay Shore shops of the Southern Pacific Railroad Company near San Francisco is a model of its kind. The building is a wooden structure with corrugated iron sides and roof. Almost the entire walls are glass. There are also numerous skylights and the building is well ventilated. An experiment has been made in the use of crushed rock and oil for the floor, which has given perfect satisfaction, this combination being much easier to stand on than concrete.

The shop is equipped to do all kinds of repair work on locomotive boilers and tenders. The equipment in the shop includes one flanging machine operated by compressed air. There is a utility forge for light jobs, and an oil burning flange fire with straightening block and flanging clamp; two combination punch and shears with 50-inch throats. A combination angle shear and punch machine, one Landis staybolt cutter, one large drill press for heavy work and small drill press for light work are also included in the equipment. There are several stationary oil forges for heating rivets and a portable forge. Acetylene welding and cutting outfits are used in cutting and welding and for brazing. These outfits are portable and use gas manufactured by portable plants.

There are two 3-inch air mains, one on each side of the building, with 1¼ inch leads and connections at each column.

There is a transfer pit 400 feet in length that extends between the erecting shop and the roundhouse and the boiler shop, which provides a quick means of transferring both locomotives and boilers from the erecting shop to and from the boiler shop and for transferring locomotives from the erecting shop to the roundhouse. A novel feature of this pit is the transfer table trailer. This trailer was built to enable hand trucks to be taken across the pit between the erecting shop and the boiler shop. It is seldom necessary to move the trailer, the only time being when the transfer table is to be moved to the extreme west end of the pit. Then the transfer table is used to push the trailer out of the way and is again towed to place when the transfer table again moves to the other end of the pit.



Section of Bay Shore Shop, Showing Type of Structure (Upper Left). A Boiler in Process of Stripping (Right). Some of the Pneumatic Tools in the Shop (Bottom).

BIGGEST TESTING MACHINE IN THE WORLD.—A crushing force equal to the weight of fifty loaded coal cars of a hundred tons each can be exerted by the largest testing machine in the world which is now being installed at the Bureau of Standards. This machine has been in use for several years at the branch laboratory in Pittsburgh and has recently been moved to the main laboratory in Washington, D. C.

Boiler Maintenance in the Roundhouse

Details of Defects and Repairs That Constitute the Most Important Part of British Terminal Maintenance

By A. Wrench

LOCOMOTIVE boiler management in the roundhouse is a subject that should be thoroughly understood by all those in charge of this work, as this important branch of maintenance work has been somewhat under-rated.

For many years, in this country (England), fitting crews had control of the boiler repairs, resulting in much inefficiency, as the average fitter does not study the stresses to which a boiler is subjected and the work suffers accordingly.

In most large terminals now, the boiler work is controlled by a foreman or master boiler maker, who has full authority to stop engines for boiler repairs, or condemn them when unfit for service. He is usually selected from the boiler makers working in the running department, who have a general knowledge of shed working, as well as an all round knowledge of the trade. He should have jurisdiction over all grades having work in connection with the maintenance of the boilers in his charge, including boiler makers, tube fitters, boiler washers, tube cleaners, firebox cleaners, firebar men, etc. If the work of these grades is neglected, the efficiency of the locomotives will be impaired by bad steaming.

Types of Repairs Required

The work generally in a running shed is different from that in railway or contract shop. The boiler maker has to be an all-round man, capable of doing a variety of work. In addition to firebox and tube repairs, he should be capable of doing repairs to engine frames, smokeboxes, tanks, and various smithing and plating work, which from time to time arise.

Tube fitters are employed in some terminals to deal with leaking tubes. These are expanded when only leaking locally, but when many are leaking or are worn thin at the ends, or there is a suspicion of dirt among the tubes, the engine is stopped and the repairs effected.

Before an engine is stopped, the foreman boiler maker should make inquiries as to the condition of the running gear, etc., and also obtain the mileage since the last shopping. If the locomotive is in a run-down condition, it may be possible to make the boiler good for 6 or 8 weeks' service by a slight repair.

Supposing a locomotive is reported by the engineer, on completion of a journey, to have leaky tubes; and, on examination, all the tubes are found to be leaking and about 40 tube ends thin, inquiry shows that the locomotive is getting run down and will be due for a general repair in about a month's time. In a case of this kind, it is possible that a further term of service can be obtained by re-expanding the tubes and inserting ferrules in those that are thin, to prevent further wear and help to keep the expanded joint tight. When the engine is stopped for general repairs, the tubes can be removed and a more permanent repair effected.

Cooperation of Departments

A good deal of locomotive stopping can be avoided by the foreman boiler maker working in conjunction with the foreman fitter.

When an engine is stopped in the roundhouse for a heavy motion repair, the firebox should be overhauled, and any repairs necessary taken in hand. It is also advisable to anticipate repairs likely to be necessary shortly after the locomotive is placed in service again.

Sometimes when an engine is stopped for a heavy repair, it will be found that the tube ends are worn, but not sufficiently badly to be renewed. If these tubes are allowed to remain in, they may give trouble after a few weeks' service, which will necessitate the locomotive being stopped for a further period. Therefore, it is good practice to renew these tubes during the first stopping.

A periodical examination should be adopted, in addition to the thorough overhaul, whenever the engine is stopped. Valuable information can also be obtained from engineers and others, whose duties keep them in touch with fireboxes, when under steam pressure.

Washing Out Boilers

An important branch of boiler maintenance is boiler washing. This is done on most railways, two or three times a week, and in some cases with hot water. Cooling down boilers too suddenly, prior to washing, accounts for a lot of firebox trouble. In smaller depots, when this work is under the control of persons not skilled in boiler maintenance, the boilers are often cooled too rapidly with detrimental results to the boiler structure, tubes, etc. The foreman boiler maker should see that the cooling is gradual.

The boiler washers should understand the construction of the water spaces they are expected to keep clean, so that, by means of rods and various shaped nozzles, they may reach any desired place where scale and sediment is likely to collect.

Cleaning Tubes

The tubes of locomotive boilers should be regularly cleaned, preferably after each trip. The dirt inside the tubes is removed by compressed air or steam blast, and any burrs which collect on the tube ends in the firebox are removed by a rake and wire brush.

Ash, which tends to collect at the front of the brick arch, should also be removed regularly, since if this is neglected, the bottom rows of tubes get blocked, reducing the heating surface and causing bad steaming. Superheater flues also get blocked with ash, owing to a clinker building up on the end of the element tubes, and falling inside the flues.

The bands which hold the elements together, sometimes become displaced and broken, and cause an obstruction in the flues against which ash will collect. If the air or the steam blower will not clear this ash, the element should be withdrawn and the flue cleaned with a mop. It is not good practice to wash the flues with the hose.

Dirt in the boiler among the tubes is often the cause of bad steaming and necessitates the removal of tubes to clean away.

It will be seen by the foregoing that boiler management in locomotive terminals plays an important part in the efficiency of the locomotive, and all work in this connection should be directly under control of a person specially skilled in boiler maintenance work.

The City of Scranton by ordinance introduced in council, adopted the boiler code of the Industrial Board of Pennsylvania as effective in that city ninety days after the approval of the mayor. The mayor signed the ordinance on March 7, 1923. This step assures uniform boiler regulations throughout the commonwealth of Pennsylvania.

Rules for Preventing Boiler Failures

Proposed A. S. M. E. Rules on Care of Power Boilers To Be Discussed at Spring Meeting

THIS Report of the Sub-Committee of the Boiler Code Committee on Code for the Care of Power Boilers is suggestive only and will be proposed for discussion at the Spring Meeting of the Society at Montreal, Que.

The work of this Sub-Committee of the A.S.M.E. Boiler Code Committee has been actively pushed forward during the past year and its report is here presented for public discussion. This report is intended to form a section of the A.S.M.E. Boiler Code, the Sub-Committee which was appointed in 1922 to consummate this work being as follows:

F. M. GILSON, *Chairman*	W. H. LARKIN, JR.
E. G. BAILEY	J. S. SCHUMAKER
W. G. DIMAN	H. F. SCOTT
J. R. GILL	N. STAHL
J. W. HAYS	J. WOLFF
S. F. JETER	

It is the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

The following outline of the proposed "Rules for the Prevention of Direct Causes of Boiler Failures" will indicate the scope of the work. The first sections on "Over-Pressure" and "Weakening of Structure" are given below. Additional sections will be published in later issues of THE BOILER MAKER.

RULES FOR THE PREVENTION OF DIRECT CAUSES OF BOILER FAILURES

Over-Pressure
- Indicators
  - steam gages
  - water glasses and gage cocks
- Relief Equipment
  - safety valves
  - intercommunicating valves between systems of different pressures
- Feed Water Control
  - pump regulators
  - feed water regulators
- Excessive Combustion
  - damper regulators
  - fuel supply regulators
- Operation
  - manipulation of valves

Weakening of Structure
- Overheating
  - lack of water supply
  - fouled heating surface
  - excessive combustion
  - secondary combustion and flaming through
  - localized heating
  - damper regulation
  - insulation
- Corrosion
  - general
  - internal
    - feed water
    - boiler out of service
  - external
    - leaks
    - boiler out of service
  - electrolysis
- Erosion
- Stresses other than Internal Pressure
  - boiler supports
  - pipe line supports
  - supports of equipment or other structures
  - safety valve escape pipe supports
  - supporting columns between settings
  - supports of blow-off lines
- Molecular Changes
- Mechanical Injuries
  - tube cleaning or scaling
  - loose connections
  - repairs

Rules for Inspections
- Preliminary
- External Inspection
- Furnace and Parts Exposed to Fire
- Internal
- Appurtenances
- Care and Management

Rules for Routine Operation
- Putting Boilers in Service
  - getting up steam
  - cutting in
- Firing Boilers
  - uniform firing
  - cleaning fire
  - banking fire
- Handling Boilers in Service
  - water level
  - foaming and priming
  - oil in burner
  - feed water treatment
  - blowing off
  - leaks
  - repairs
  - removal of soot and ashes
- Care of Appliances
  - safety valve
  - steam pressure gage
  - water glass
- Handling Boilers Out of Service
  - cutting out
  - cooling off
  - emptying
  - cleaning
  - laying up

Over-Pressure

INDICATORS

C-1 *Steam gages.* Steam gages shall be placed where they will be free from vibration and where they can be conveniently adjusted. They shall be so placed that they will not be subjected to a temperature of less than 40 degrees F. or more than 150 degrees F. They shall be of such size and so proportioned and marked that the position of the pointer and the graduations can be clearly determined by a person with normal vision standing on the operating floor at any point within a radius of one and one-half times the width of the boiler setting measured from the center of the boiler front. Steam gages on all boilers, where set in battery, shall be practically the same in size and graduation of face.

C-2 Steam gages shall be well lighted at all times. When natural light is used the gage shall be so placed that the rays of light will not cause a reflection upon the glass cover thus obscuring the dial when viewed from the most desirable points of observation. When artificial light is used the light shall fall directly upon the face of the gage. Whatever form of light is used, no light shall fall directly into the eyes of the operators when looking at the gage from the most desirable points of observation.

C-3 Where steam gages are installed with waterleg, compensation shall be made in the gage to neutralize the effect of the water in the gage connections. Where steam gages are placed high above the operating floor, they shall be tilted forward at a sufficient angle (not to exceed 30 degrees with the vertical) to permit a proper view of the dial graduations.

C-4 Piping for steam gages shall be as short as practicable and shall be free from pockets and air traps. When the pipe line is longer than 10 ft., the pipe size shall not be less than ⅜ inch standard pipe size.

C-5 A steam gage shall be considered tested when it has been compared and made to agree with a test gage or dead weight testing device, unless compensation for waterleg has been made, in which case an equivalent allowance shall be made in the reading of the test gage or dead weight testing device. The test gage shall be a reliable gage that is used exclusively for testing gages in service and one that is tested and maintained in agreement with a dead weight testing device.

C-6 Boiler gages shall be tested frequently, at times of external inspection, when boiler is placed in service, and when safety valve is operating and the pressure indicated by the steam gage is not in agreement with the pressure at which the safety valve is set to open.

C-7 A master gage is an auxiliary gage attached to the main header indicating the composite boiler pressure of the whole battery; it is used in the general operation of the plant mainly as a matter of convenience. Master gages shall be tested at least every three months and more frequently when trouble is experienced with boiler compounds, foaming, priming and other feed water troubles that are apt to cause choking of the gage piping.

C-8 All steam gages shall be within two per cent of error in the range between the working pressure and the pressure of the opening of the safety valve.

C-9 Before a steam gage is tested, it shall be disconnected at the gage union while the piping, cock and siphon is being cleared by blowing through. A tee with a plug shall be placed between the siphon and the gage for the purpose of connecting the test gage. Care shall be taken not to admit steam directly into the gage, making sure at all times that the siphon is filled with water. In opening the connection to the gage, the operator shall open the cock slowly while holding one hand on the siphon until the gage indicates full boiler pressure; if the temperature of the siphon indicates that steam instead of water is entering the gage, the cock shall be closed until a sufficient amount of water has accumulated in the piping.

C-10 When laying up a boiler, particularly in freezing temperatures, the gage connection shall be drained and the gage shall be disconnected and stored away in a non-freezing room.

C-11 The dial and glass cover of steam gages shall be kept clean at all times. The glass cover joint shall be tight and, whenever the glass is broken, it shall be replaced as soon as possible.

C-12 *Water Glasses and Gage Cocks.* The valves and connections between the boiler and water column shall be kept free and clear and shall be tested by blowing down the water column, noting the return of water in the glass, and trying the gage cocks until sure of the water. They shall be tested by the responsible operator on the relieving shift before the relieved shift has gone off duty, also after replacing or cleaning the water glass and when a boiler is put in service.

By *shift* is meant a person or group of persons who relieve a person or group of persons in rotation in standing watch or operating a steam generating plant for an allotted time. It is synonymous with watch, vigil or tour of duty.

C-13 The water glasses and their connections shall be kept free from leaks and no alterations, allowing a flow of water from the piping between the water glass and the boiler, shall be made.

C-14 The outlet end of the discharge pipes from the water columns, water glasses and gage cocks shall be kept open and either in sight or in hearing of the operator while blowing down.

C-15 The water glasses shall be so lighted that the level of the water in the glass can be readily seen from the most desirable points of observation and the light shall be so shaded that it will not shine directly into the eyes of the operator when looking at the glass. The inner and outer surfaces of the water glass shall be kept free from deposits of dirt and the connections of the water glass shall be so arranged that the inner surface of the glass can be cleaned by forcing through the glass a piece of cloth, free from lint and dirt, wound about a smooth piece of wood. Types of gage glasses and guards which prevent the free observation of the glass shall not be used.

C-16 Where automatic alarms for indicating extreme low water level or extreme high water level are used, they shall at all times be kept in good working order but shall not be depended upon in maintaining a proper level of water in the glass. When an automatic alarm sounds and the level of the water is not visible in the glass, the operator shall test the try cocks to determine the water level before manipulating the feed water valves.

C-17 *Fusible Plugs.* Fusible plugs, if used, shall be kept in good condition and shall not be used for more than one year as provided for in Par. 428 of the Rules for the Construction of Power Boilers. When the boiler is open, the exposed surfaces of the fusible metal shall be scraped clean and bright and the surface of the boiler near the plugs shall be scraped clean. If the fusible metal does not appear sound, the plug shall be renewed. If used plugs are refilled, all of the old filling shall be removed, the surfaces of the shell scraped bright and properly tinned and the plug filled with pure tin as specified in Par. 428 of the Rules for the Construction of Power Boilers. Fusible plugs shall not be refilled with used metal.

Relief Equipment

C-18 *Safety Valves.* All safety valves shall be kept clean and in working order.

C-19 The capacity of safety valves shall be calculated as provided for in Pars. 269-290 (inclusive) of the Rules for the Construction of Power Boilers, under the following conditions and if necessary a larger safety valve installed: when the allowable working pressure of a boiler has been reduced, when a boiler is equipped with increased stoker capacity or when a change in fuel permits increased combustion.

C-20 Whenever the stipulated blowing pressure of a safety valve is ten percent higher or lower than the pressure for which the spring of the valve is designed, the safety valve shall be equipped with a new spring complying with the requirements given in Pars. 269-290 (inclusive) of the Rules for the Construction of Power Boilers.

C-21 When a safety valve spring has weakened and has been further compressed to secure the stipulated blowing pressure, an examination of the spring shall be made in order to insure its compliance with the rules given in Pars. 281, 282 and 284 of the Rules for the Construction of Power Boilers.

C-22 Where boilers are set in battery and operating under the same working pressure and some of the boilers have allowable working pressures greater than others, all safety valves shall be set to blow off at a pressure not in excess of that allowed on the weakest boiler.

C-23 Safety valves shall be tested at least once a day by gently raising the valve off the seat by hand and, when practicable, shall be tested daily by raising the steam pressure to the blowing pressure of the safety valve. Small chains or wires attached to the lever of pop safety valves and extended over pulleys to other parts of the boiler room may be used.

C-24 When a safety valve sticks or fails to operate at the stipulated blowing pressure, no attempt shall be made to free it by striking the body or other parts of the valve but the boiler shall be taken out of service and the safety valve examined.

C-25 The safety valve, when blowing, shall be checked against the boiler gage and when the pressure noted on the boiler gage varies more than five pounds from the stipulated blowing pressure, the boiler gage shall be tested and if found correct, the safety valve shall be corrected.

C-26 The setting and adjusting of safety valves shall be done by a competent person. When safety valves are set or adjusted, the level of the water in the boiler shall not be above the highest gage cock.

C-27 In order to insure that the freedom of the spring is in compliance with the Rules given in Pars. 282 and 284 of the Rules for the Construction of Power Boilers, it shall be tested whenever the valve spring is adjusted.

C-28 After a hydrostatic test has been made, special care shall be taken to see that the safety valve is immediately restored to its proper operating condition.

C-29 Leaking safety valves shall be repaired or replaced as soon as discovered.

C-30 Care shall be exercised to prevent the accumulation of dirt, scale or other foreign matter between the coils of the spring.

C-31 The discharge from the open end of the escape pipes shall be unobstructed and, if practicable, inside of the boiler house within hearing of the operator.

C-32 All supports and anchors that are attached to the escape pipe, shall be tested every six months and the proper tension maintained.

C-33 Escape pipe drains shall be examined monthly and the escape pipes shall be disconnected once a year in order that the drain may be kept free and clear at all times.

C-34 *Intercommunicating Valves Between Systems of Different Pressure.* Where intercommunicating systems of different steam pressures are installed with boilers on each system, the boilers on the low pressure systems shall be equipped with non-return check valves. All low pressure headers and their outlets shall be protected by a relief valve or valves whose combined capacity shall be equivalent to the total amount of steam that can pass from the higher pressure system into the lower pressure system. Where a reducing valve is used, a hand valve shall be installed. Also a steam gage shall be installed at a convenient point for the guidance of a person when operating the hand valve in lieu of the reducing valve.

C-35 Whenever the total amount of steam that can pass from a higher pressure system into a lower pressure system has been increased, the relief valve capacity shall be increased an equivalent amount in accordance with Par. 34.

Feed Water Control

C-36 *Pump Regulators.* Feed pump pressure regulators shall be maintained in good condition and shall be frequently tested under closed discharge. When duplicate pump is not installed the pressure regulator shall be by-passed.

C-37 When feed water pressure increases above normal, the feed lines shall be examined for possible choking due to scale or other causes.

C-38 *Feed Water Regulators.* Where feed water regulators are used they shall be by-passed and shall be kept in good working condition but shall not be depended upon to maintain a proper level of water in the boiler.

Excessive Combustion

C-39 *Damper.* Damper regulators and draft control devices shall be kept in good working condition and shall be so installed that any failure of or accident to the mechanism of the damper will cause the damper to open and not to close.

C-40 *Fuel Supply.* Fuel supply regulators shall be kept in good working condition and shall be so installed that any failure of or accident to the mechanism of the regulator will shut off the supply of fuel to the boiler and, once having shut off the supply of fuel, will not automatically resume the supply of fuel.

Operation

C-41 *Manipulation of Valves.* When cutting in a boiler, the stop valve shall be opened slowly to avoid water hammer and, where non-return check valve or stop and check valve is not installed, it shall be opened only when the pressure in the boiler is exactly the same as the pressure in the main boiler header. Where a non-return check valve or stop and check valve, as the case may be, is installed, it shall always be used automatically for cutting in and cutting out of the boilers; the main stop valve, in cutting in a boiler, shall be opened when the pressure on the boiler is still ten or fifteen pounds less than that on the main and, in cutting out the boiler, the main stop valve shall not be closed until after the non-return check valve has closed. Care shall be taken to drain the piping between the main stop and non-return check valves before cutting in the boiler.

Weakening of Structure

Overheating

C-42 *Lack of Water Supply.* Special and constant care shall be exercised to maintain a proper and uniform water level in the water gage glass and to provide a continuous rather than intermittent supply of water to the boiler.

C-43 The water tender or any operator responsible for maintaining water in the boiler shall not permit any inattention, other duties or reliance upon automatic devices to interfere with the performance of his duty in preventing low water level in the boiler.

C-44 Where practicable, a duplicate source of supply of feed water, pump or injector and piping systems to the boilers shall be installed. Where two systems of piping to the boilers are used, it is recommended that the two systems enter the boiler at different points. Feed pumps and injectors shall be maintained in good condition.

C-45 Leaks in the feed discharge line or elsewhere shall be stopped as soon as possible.

C-46 Sufficient water shall be maintained in feed water tanks to prevent loss of suction in the feed pumps and, where hot water is fed to or allowed to splash in feed water tanks, sufficient water shall be maintained in the tank to prevent entrainment of vapors.

C-47 Feed lines shall be free from objectionable vibration due to feed pump.

C-48 Where electrically-driven feed pumps are used, there shall be maintained, ready for service, steam-driven feed pumps of sufficient capacity to safeguard the boilers in case of failure of electric power.

C-49 Restricted areas in feed lines, such as meter tubes, orifice plates, etc., shall have a by-pass equivalent in size to pipe line.

C-50 Where economizers are installed in the feed line, they shall have a by-pass equivalent in size to pipe line.

C-51 All feed water tanks shall be cleaned out frequently to prevent the accumulation of objectionable sediment.

C-52 When feed water tanks are installed, and the water level cannot be observed easily by the water tender, suitable water glass or water level indicators shall be installed.

C-53 Frequent inspections shall be made to detect scale and defective check valves in the feed line.

C-54 Feed water regulators or other automatic devices shall be maintained in good working order.

C-55 If difficulty is experienced in maintaining the proper water level, the combustion shall be checked and the draft dampers and ash pit doors closed until the cause is discovered and corrected.

C-56 If the level of the water is not visible in the water glass, the gage cocks shall be tested to ascertain whether the level of the water is above or below the water glass. If the level is below the water glass, the supply of fuel and air shall be stopped and the dampers and ash pit doors closed. The feed water valve shall be closed and under no circumstances shall any attempt be made to admit water to the boiler. The fire shall be hauled or in case of stokers or chain grates, the grates shall be kept in motion and the fire doors shall be left open. Water from fire or other hose shall not be thrown upon the fire. The safety valve shall not be opened, steam outlet valves shall not be changed nor shall any change be made that will cause a sudden change in the stresses acting upon the boiler. The blow-off valves shall be examined and, if found defective, repaired. The cause of the failure of water supply shall be determined and remedied.

C-57 Where both cock and valve are used in the blow-off line, the cock shall be placed between the valve and the boiler. All blow-off cocks and valves shall be kept free from leaks and in good working order.

(To be continued in the June issue)

Complete Program of Master Boiler Makers' Convention

THE business sessions of the fourteenth annual convention of the Master Boiler Makers' Association will be held May 22, 23, 24 and 25, 1923, at the Hotel Tuller, Detroit, Mich., which will be headquarters for the association.

The secretary will have an office in the hotel for the transaction of general business outside of the convention.

Registration will begin at 2 P. M. Monday, May 21. Each member is urged to report promptly at Registration Booth, after his arrival for himself and ladies, etc., and receive convention badges, with such instructions as may be of value during the convention. This will prevent confusion and possible disappointments.

No badges will be issued until after registration, at which time dues must be paid to the secretary or his representative.

FIRST DAY

Tuesday, May 22, 1923.

REGISTRATION OF MEMBERS AND GUESTS CONTINUED AT 8 A. M.

In order to participate in entertainments badges will be required. None will be issued unless your dues are paid and you are properly registered. *No deviation from this rule.*

BUSINESS SESSION

10:00 A. M.—Convention called to order.

Invocation.
Address—Mayor of Detroit.
Annual address—Thomas Lewis, President of the Association.
Routine Business—
Annual report of the Secretary, Harry D. Vought.
Annual report of the Treasurer, W. H. Laughridge.
Miscellaneous Business—
Unfinished business.
New business.
Appointment of special committees to serve during convention:
Resolutions.
Memorials.
Announcements.
Adjournment.

SECOND DAY

Wednesday, May 23, 1923.

9:00 A. M.—Convention called to order.

9:05 to 9:25 A. M.—Addresses—Walter H. Flynn, of Detroit, S. M. P., I. C. R. R. A. G. Pack, Chief Inspector of Locomotives, I. C. C.

Committee Reports

9:30 to 10:00 A. M.—"Hammer Testing of Staybolts on Our Modern Locomotive Boilers Is Now One of the Most Important Duties of Local Boiler Inspectors."—J. A. Holder, Chairman.

10:00 to 10:30 A. M.—"Are the New Combustion Chamber Boilers as Easy to Maintain as the Straight Standard Firebox?"—Henry J. Raps, Chairman.

10:30 to 11:00 A. M.—"The Finished Material (Boiler Plates) Should Be Sound and Free from Cracks, Surface Flaws and Laminations, and No Hammer Dressing, Patching, Burning or Electric Welding Is Allowed."—Charles P. Patrick, Chairman.

11:00 to 11:30 A. M.—"Is the Use of Automatic Stokers on Locomotive Engines Injurious to the Firebox Sheets? Do the Firebox Sheets Crack More Readily in a Stoker-fired Engine Than in a Hand-fired Locomotive?"—H. A. Bell, Chairman.

11:30 to 12 M.—"What Are the Best Methods of Detecting Defective Boiler Sheets in the Shop Before Going to the Laying Out Bench and Put Into Service?"—John J. Keogh, Chairman.

Announcements.
Adjournment.

THIRD DAY

Thursday, May 24, 1923.

9:00 A. M.—Convention called to order.

9:05 to 10:00 A. M.—Address—Frank McManamy, Mechanical Division, Liquidation of Claims, U. S. R. R. Administration, Washington, D. C.

Committee Reports

10:00 to 11:00 A. M.—"What Is the Standard Method of Applying Flues in Locomotive Boilers; Also in Stationary Boilers?"—Albert F. Stiglmeier, Chairman.

11:00 to 11:30 A. M.—"The Life of the Superheater Tube and the Number of Safe-ends That Should Be Applied Before They Are Cut Down for a Smaller Boiler."—J. P. Malley, Chairman.

11:30 to 12:00 M.—To report Topics for 1924 convention.—John F. Raps, Chairman.

12 M. to 12:30 P. M.—"Care of Water Tube Stationary Boilers."—J. J. Davey, Chairman.

Announcements.
Adjournment.

FOURTH DAY

Friday, May 25, 1923.

9:00 A. M.—Convention called to order.

9:00 to 10:00 A. M.—Addresses—

"Steam Leaks and the Bad Effects on the Boiler Plate."—D. A. Lucas, Chairman. (No report filed.)

"What Experience Has Been Had in Connection With the Electric Weld Heater?"—John W. Holt, Chairman. (No report filed.)

Report of Committee on Rules for Recommended Practice and Standards.—Leonard C. Ruber, Chairman.

10:00 to 10:30 A. M.—Report of Committee on Law.—Thomas F. Powers, Chairman.

Unfinished Business:

10:30 to 10:35 A. M.—Report of Committee on President's Address.

10:35 to 10:45 A. M.—Report of Committee on Resolutions.

10:45 to 11:00 A. M.—Report of Committee on Memorials.

11:00 to 11:45 A. M.—Election of Officers.

11:45 to 12:30 P. M.—Good of the Association and General Discussion.

12:30 to 1 P. M.—Announcements and Closing Exercises of the Convention.

The Women's Auxiliary of the Master Boiler Makers' Association

The Women's Auxiliary of the Association will also hold its annual meeting at the Tuller Hotel at 10 A. M. Wednesday, May 23, 1923.

OFFICERS

Honorary President—Mrs. John McKeown, Galion, O.
President—Mrs. Andrew Greene, Indianapolis, Ind.

VICE-PRESIDENTS

First—Mrs. James E. Cooke, Greenville, Pa.
Second—Mrs. C. F. Petzinger, Macon, Ga.
Third—Mrs. C. F. Finnaly, Jersey City, N. J.
Fourth—Mrs. Charles L. Hempel, Omaha, Neb.

SECRETARY-TREASURER

Mrs. A. N. Lucas, 170 22nd street, Milwaukee, Wis.

The Boiler Maker

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H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

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WE GUARANTEE that of this issue 5,000 copies were printed; that of these 5,000 copies, 4,196 were mailed to regular paid subscribers; 21 were provided for counter and news company sales; 76 were mailed to advertisers; 63 were mailed to employees and correspondents, and 644 were provided for new subscriptions, samples, copies lost in the mail and office use, that the total copies printed this year to date were 24,300, an average of 4,860 copies a month.

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

The Boiler Maker *announces the removal of its office from the Woolworth Building to 30 Church street, New York.*

The locomotive boiler explosion reports of the Chief Inspector of the Bureau of Locomotive Inspection, noted elsewhere in this issue, bring home rather forcibly the humanitarian side of disasters of this kind. The method of detailing the events leading up to the boiler failures, even to including the conversations of the principals in the tragedies just before their lives were snuffed out emphasizes the fact that these men, through no fault or carelessness of their own, were compelled to forfeit their existence because of the demands of service.

Not all explosions are preventable, but many of them can be avoided by the careful observance of those principles of practice—and we are speaking of boiler maintenance practice—that are known to be good and that will insure safe locomotives on the road. The tendency of some roads is to keep locomotives in service when it is evident that, although they may not be absolutely unsafe to operate, nevertheless they do require certain repairs to keep them out of the danger class.

It would be difficult to imagine a more seemingly unimportant item of boiler attachment than the running board bracket stud connected to the boiler, mentioned in the Chief Inspector's report as responsible for the serious injury of three men. Even a loose stud where it is exposed to the working pressure of the steam in the boiler may thus become a menace to safety. Apparently no item is so small that it can be overlooked, and here is where the function of the boiler maker begins, for it is his duty to see that boilers are properly conditioned when brought to the shop and that every part, however small, is as it should be. The safety and incidentally the happiness of a great many individuals rest on the shoulders of the men whose duty is the proper maintenance of boiler equipment.

Two papers on boiler materials, prepared by special committees of the Master Boiler Makers' Association for discussion at this year's convention, introduce a subject upon which the safety of the finished boiler largely depends. Too few of the men in the shops understand how materials are produced and the methods employed to insure freedom from flaws and defects of a chemical or physical nature which would possibly be detrimental to the structure if used in boiler construction.

It may be argued that information of this character is too general and unnecessary for the practical work of boiler fabrication or repair. But actually a better understanding of the boiler materials required is as essential as a knowledge of the tools used in building a boiler. At every stage in the construction, sharp watch must be kept to detect any flaws that might develop in the working of the material and, if a man knows how flaws are liable to develop, or what form defects of both an ordinary and unusual character assume he will be better able to fulfill the work entrusted to him, and do his part in building safer boilers.

Laboratory methods for testing materials have been adopted by many roads and locomotive builders in this country and, although a knowledge of laboratory procedure is not absolutely necessary, it is well for every boiler maker—particularly master boiler makers and foremen, to understand how the qualities of the materials they use are determined. The article in this issue on "Materials" briefly outlines the laboratory methods employed by one of the greatest locomotive building concerns in the world and represents the most up-to-date practice in testing boiler materials.

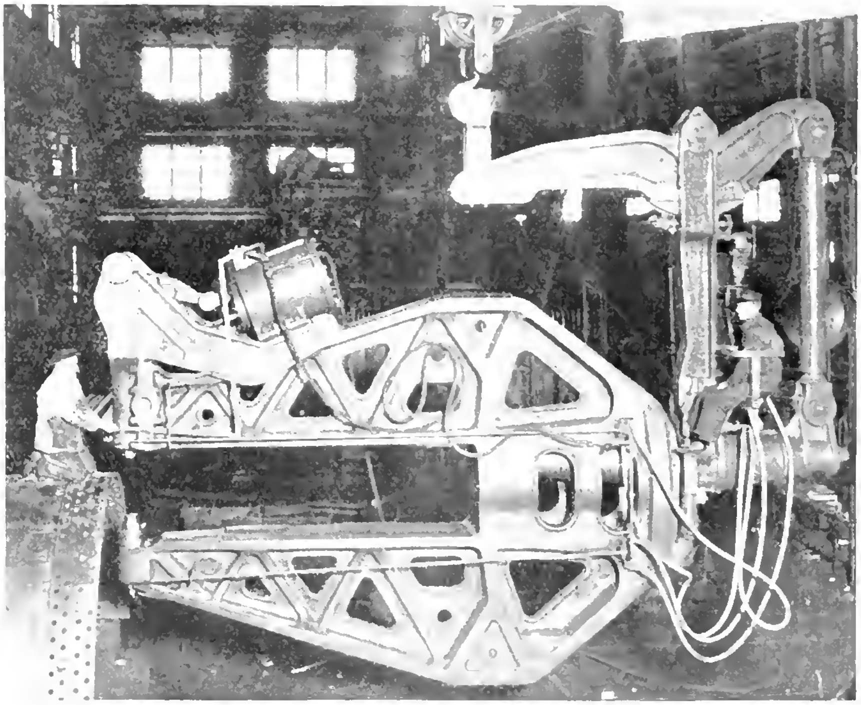
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Portable Pneumatic Riveter

The Hanna Engineering Works, Chicago, Ill., has recently completed a 150-ton portable pneumatic riveter of 118 inch reach and 30 inch gap, which it designed and built specially for the Niagara Falls Power Company.

The riveter is built primarily for fabricating the plates forming the volute of the casing (spiral or snail shell) and penstock for a 70,000 horsepower hydraulic turbine. The greatest distance across the volute is approximately 48 feet and the diameter of the entrance for water into the volute is 15 feet. The plates vary in thickness from $1\frac{1}{4}$ inch at the entrance to $\frac{7}{8}$ inch at the end of the volute, with rivets of diameter from $1\frac{1}{2}$ inch to 1 inch and 7,800 in number. The longest grip for the $1\frac{1}{2}$-inch rivets is approximately 5 inches. The penstock is approximately 18 feet in diameter with plates of $1\frac{1}{2}$ inch thickness and about 110 feet long. Three such penstocks are to be riveted. Since the volute and penstock are to hold water under a pulsating pressure of about 110 pounds per square inch, the character of this work must be of boiler quality. Owing to the immense size and weight of the volute and penstock, a portable riveter is required. The large rivets and large plates call for a riveter of high tonnage and long reach.



Side Elevation of Portable Pneumatic Riveter

The riveter is clearly shown in the accompanying illustration which is a side elevation with the spindle horizontal, the frame vertical and with riveting mechanism above.

The total portable weight of the riveter is 57,750 pounds and the weight of the frame, a one-piece steel casting, without spindle or riveting mechanism, is 33,000 pounds. The largest portable machine built by Hanna Engineering Works prior to this weighed 25,000 pounds, and was believed to be the heaviest portable machine in use. The great weight of this later riveter, combined with its form of suspension, which approaches complete universability, makes it of unusual interest.

Mechanical Power Operates Riveter Into Position

It is evident that mechanical power is necessary to move this riveter into the operating positions. The supporting mechanism is designed so that when revolving the frame on the spindle or tilting it upward or downward from the horizontal, the center of gravity of all the parts hanging upon the crane hook is neither raised nor lowered. This is accomplished by the suspension beam (at top)), the two vertical links, the spindle housing and spindle which form a parallelogram with overhung support at the crane hook directly above the center of gravity of the entire machine. With this arrangement the friction of the bearings and the inertia effects are the only forces to be overcome. These two motions, revolving and tilting, are performed by two reversible, close quarters, air drill motors of approximately 2 horsepower each, manufactured by the Chicago Pneumatic Tool Company. The motor for tilting is mounted upon the inner vertical (tension) link and drives a worm gear which engages with a worm gear sector upon the suspension beam. The tilting motion is limited to 30 degrees below the horizontal. The motor for rotating is mounted upon the spindle housing and drives a full worm gear upon the frame. This makes it possible to set the frame at any required angle around the spindle. Incorporated in this drive is means to absorb the shock of stopping the massive frame, thus relieving the drive mountings of what otherwise would be unmanageable forces.

In order to minimize the power necessary to set the frame into the required position, roller bearings and ball bearings are employed at all points of rotation. The frame is mounted upon the spindle by two radial roller bearings, and is restrained from longitudinal motion upon the spindle by roller thrust bearings. Four roller bearings, one at each end of the vertical links, and two large ball bearings at the crane hook end of the suspension beam, come into action when tilting the frame. The roller bearings on the inner vertical link carry a load of approximately 150,000 pounds each.

Lubrication is by oil bath and positive pressure grease system. All moving parts are so arranged as to be completely protected from the elements.

The Hanna motion, or riveting mechanism mounted upon this machine is a combination of toggles which merge into a lever action, developing a known and pre-determined maximum uniform pressure during the lever action, which is the last half of piston stroke, or what amounts to the last inch of die travel. This assures of tight rivets being driven with each stroke of the piston, without any adjustment of the die screw being necessary to overcome the ordinary variation in length of rivets, thickness of plates, diameter of holes, etc. An accurate adjustment of the die screw is, therefore, unnecessary, and no particular knack or skill is required of the operator.

Three other features of interest may be mentioned. The first is the demountable head or rivet driving mechanism, which possesses obvious advantages. The second is the movable buck-up die, or dead die. Engaging sets of crown cams, one set upon the die and one set upon the frame, serve to raise the die when die is given a motion of rotation through 60 degrees. When in this raised position, the die is supported upon flat surfaces, normal to its axis. The third feature is the design of frame, which is best shown in the illustration.

By employing the true truss or continuous beam form with open webs, the casting problem is simplified, owing to the absence of continuous surfaces with their resulting strains, due to cooling. In addition to this, the stress conditions under service can be more definitely determined, and hence the material may be more advantageously proportioned and located.

Complete manipulation of this machine is possible from one position at the head or dies, three valve operating handles being located here for riveting, rotating and tilting. A seat is provided near the rear of the machine from which the rotating and tilting motor valves may be manipulated when operating conditions make this point of control more desirable. In the latter case, the standard reversing valves built into the motors are utilized.

New Spiral Fluted Staybolt Tap

A staybolt tap, designed for long life and having special construction and operation features, has been developed and patented by W. L. Brubaker and Brothers Company, Millersburg, Pa. In producing this tap Brubaker engineers utilized the vast amount of data on boiler staybolt tapping collected over the period of nearly forty years in which this company has been active and attempted to eliminate the troubles common to staybolt taps.

After the design was completed, taps were put in use in shops all over the world and tested through a period of three years, in order to determine the value of the tap in service. The results obtained indicated that the new tap had a decided advantage over any tap that the Brubaker Company had made prior to this time.

Due to the special taper with which the tap is designed, the life of the tap, as nearly as can be determined from tests, has been increased about 20 percent. This taper is so designed that it distributes the work along the entire length of the tap, thus making each part of the tap perform the same amount of work as every other portion. At high speeds, it is claimed that vibration is very greatly reduced, thus permitting more holes per day to be tapped and decreasing the man power required to hold the tap in place while in operation.

The tap has a free cutting edge and it has been found that the motor speed can be increased without injuring the tap, because of the reduced friction. The results of overheating taps are too well known to require comment. By reducing friction, the heat generated during the tapping operation is decreased and consequently the dulling action which takes place when the heat softens the tap in spots. Reducing friction also brings about a saving in power.

This tap has a special standardized relief which is uniform for every tap. It is a combined machine and hand relief.

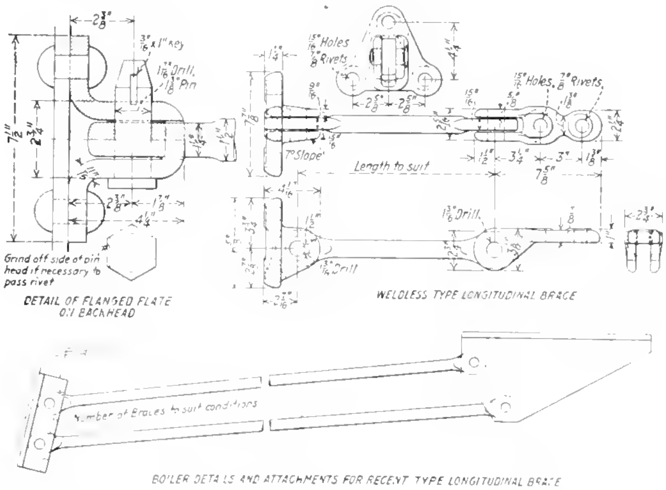
Spiral Fluted Staybolt Tap in Action

Another feature of the tap is that it is made of a special steel having a composition that gives long life and eliminates breakage under ordinary service conditions. The tap is specially tempered so that it is kept within the lead tolerances after machining, and so that the cutting quality is in no way impaired. The temper is standard for all taps giving a proper cutting quality and a soft center.

The new Brubaker staybolt tap is made in all styles and to meet all tapping requirements.

Weldless Boiler Brace

A weldless brace for use in locomotive boilers has been developed by J. G. Blunt, chief mechanical engineer of the American Locomotive Company, Schenectady, N. Y. This brace, as may be noted in the arrangement shown in Fig. 1, has no jaws on the rod, the jaws being formed in the brace



Figs. 1 and 3.—Type of Weldless Brace in Service and Recent Developments in Brace

feet, which are drop forged. With this type of brace it is claimed that a smaller brace can be used and still meet the requirements of the American Society of Mechanical Engineers' Boiler Code.

This style brace was applied on the Union Pacific, Moun-

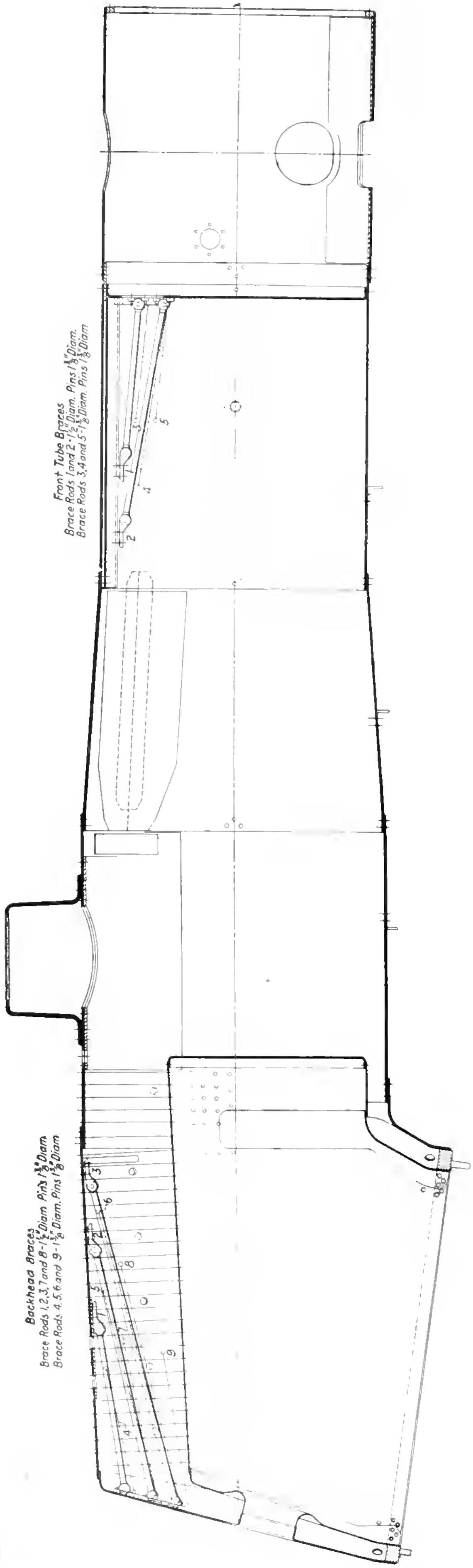


Fig. 2a.—Union Pacific Mountain Type Boiler Equipped with New Weldless Longitudinal Brace

tain type locomotives recently completed. Figs. 2a and 2b show the installation as made on these locomotives. It is now the American Locomotive Company's practice to apply

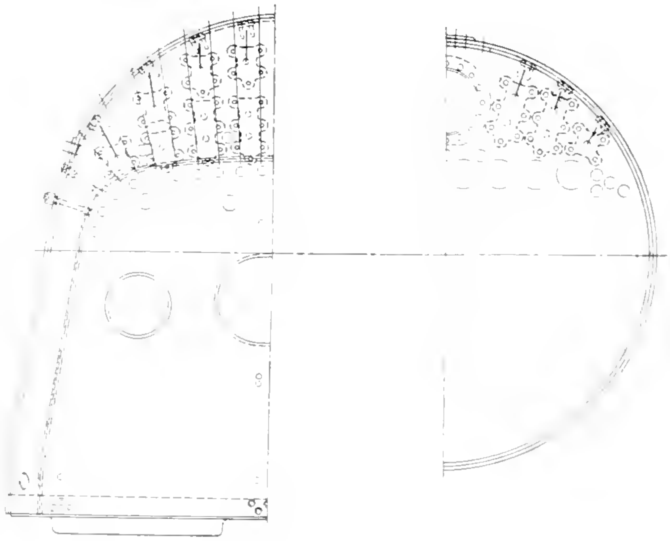


Fig. 2b.—Boiler Sections Showing Brace Feet

the boiler brace foot on the barrel courses, thereby doing away with one weld in the rod and putting the jaw on the other end to fit the tee iron, riveted to the backhead and front tube sheet.

A later development of the weldless brace is shown in Fig. 3, which is designed to do away with the drop forgings which constitute the most expensive feature of this device. This type is being used on the Canadian National locomotives now under construction at Montreal.

Either type brace will meet the American Society of Mechanical Engineers' Boiler Code requirements or those of the Interstate Commerce Commission.

BUSINESS NOTES

Thomas O'Brien, who has been connected with John F. Allen Co., New York, as engineer and sales manager for the past 12 years, has been made general manager.

Rex C. Wilson has severed his connection with the Coatesville Boiler Works, Coatesville, Pa., as designing engineer to assume like duties with the Downingtown Iron Works, Downingtown, Pa.

W. C. Thatcher, assistant superintendent of construction of the National Boiler Washing Company, with headquarters at Chicago, has been promoted to general superintendent of construction, succeeding J. M. Weir, resigned.

Thomas E. Williams, superintendent of the Empire plant at Niles, of the Youngstown Sheet and Tube Company, Youngstown, Ohio, has also been placed in charge of the Thomas sheet mill works, succeeding Harry H. Holloway, who resigned to become identified with the Apollo Steel Co., Apollo, Pa.

The following changes in personnel have been announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.: Graeme Ross has been appointed manager of the Kansas City branch office of the Electric Company to succeed F. F. Rossman. E. L. Doty, district service manager of the Buffalo branch office of the Electric Company, is appointed engineering assistant, service department, with headquarters at East Pittsburgh. J. A. Atkinson has been appointed Buffalo branch service manager.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

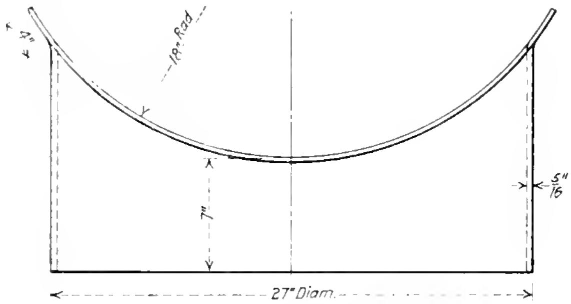
Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Flanging Dome Shells

Q.—Will you kindly give me information as to the method you would suggest for flanging on the sectional flanging machine the boiler dome sheet as shown on sketch attached. There is some difference of opinion as to which is the best way to flange this sheet and any suggestion that you may have to offer will be gratefully accepted.—S. T.

A.—The flanging of dome shells where there are a large number of the same size to be flanged, can be carried out to



Details of Dome Sheet

the best advantage by the use of *formers* or *dies;* either on a four column or sectional flanging press. With the use of dies the flange starts to form at the point of least bend as shown at *a*, Fig. 1. From the point *a* the metal is upset gradually around the entire base of the dome to the point *b* which is at the maximum or right angle bend.

This system of flanging should be applied in any other method of flanging, because the metal will flow or shape it-

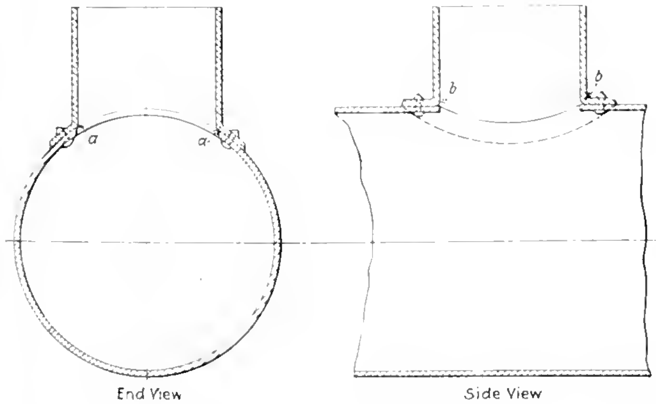


Fig. 1.—Stages in Flanging of Dome

self gradually from the point of least resistance to the point where the greatest resistance occurs, thus offsetting any undue stresses in the metal and reducing the possibility of tearing the plate from the outer edge toward the knuckle of

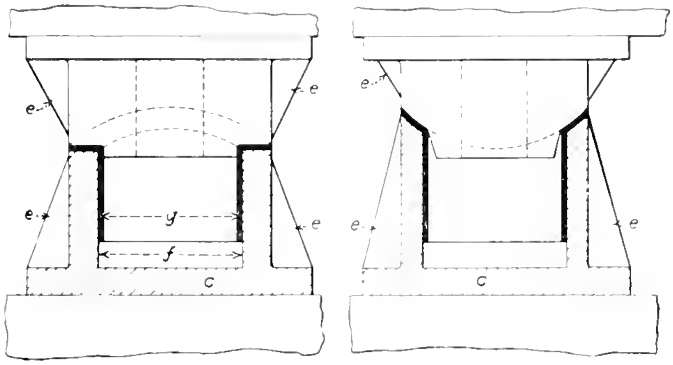


Fig. 2.—Dies Used for Flanging Domes

the flange. Buckles are not so likely to occur by this method in hand flanging.

The dies are made to conform with the shape of the flange required and based on the developed views of Fig. 1. Thus in Fig. 2 is shown the male die *c* and female die *d* so constructed along their flanging faces to form the developed flange. Castings are made of sufficient strength and reinforced against lateral stress by webs *e*.

The inside diameter *f* of the female die should equal the outside diameter *g* of the dome shell, plus a clearance allowance of 1/8 inch. The female die is made in two sections hinged and clamped so that the shell can be easily installed and removed. Both dies can be so designed sectionally that domes of the same size but of different plate thickness can be handled on the one set.

Calculating Plate Thickness

Q.—In THE BOILER MAKER of July last appeared an article entitled "Calculating Thickness of Plates and Size of Stays for Rectangular Tanks" by John S. Watts. The last paragraph of the said article is not quite clear to me. Will you please arrange to make it clear for me by an example? Also will you please show me how to find the test pressure of the following pumps chambers. Examples will be much appreciated. Feed Pump, bilge pump, oil fuel pump, air pump, circulating pump (centrifugal type).—L. T.

A.—The application of the formula

$$t = 0.62 \sqrt{\frac{P \times L^2 \times l^2}{S\,(L^2 - l^2)}}$$

in the tank problem given in July issue of THE BOILER MAKER may be illustrated as follows:

Assume that the sides of a tank are divided into rectangular sections 24 x 26 inches and so stayed as explained in the article, consider that the lateral pressure is 1½ pounds per square inch. Substituting the values chosen in the formula

$$t = 0.62 \sqrt{\frac{1\frac{1}{2} \times 26^2 \times 24^2}{10{,}000\,(26^2 - 24^2)}} = 0.32 \text{ or } 5/16 \text{ inch.}$$

Testing Pumps

The test pressure in testing for tightness is usually taken at the working pressure. For illustration, in testing pump air chambers the openings into the chamber are closed and air admitted until the working pressure is reached, as indicated by a pressure gage. The air chamber under pressure is allowed to stand for a certain period, usually 24 hours, and during this test there should be no reduction in the pressure. If there are a number of leaks, the chamber should be condemned.

The tightness of the pump plunger, or piston, stuffing boxes and valve arrangement are also tested. The manner of testing depending on their design.

The pump cylinder or cylinders in such tests are subjected to air or hydrostatic pressure on one side of the piston, equal at least to the working pressure. During the period that pressure is on one side of the piston, the other side is suitably exposed for inspection. The suctions and discharge valves are tested separately. Special testing apparatus is essential for testing centrifugal pumps and their capacity.

High pressure pumps, as fire engine pumps, are tested, from 1½ to 2.4 times the working pressure to determine strength.

Bracing and Heating Surface Calculations

Q.—Please let me know how to find out what pressure a 1⅛-inch welded boiler stay will support with 6,000 pounds stress on it. Also a 1⅛-inch stay *not* welded. What is the best rule for finding the heating surface of the boiler? I would like to take an examination for boiler inspector at Harrisburg, and anything that will help me in accordance with the Boiler Rules of the A. S. M. E. Boiler Code will be appreciated very much. I have studied the Boiler Code, but there are lots of rules that I cannot understand. If it is not too much trouble, you might show me how to find the pressure on stayed surface and rule for bracing boiler.—J. D. B.

A.—The allowable stress on a stay 1⅛ inches in diameter having an allowable stress of 6,000 pounds per square inch is determined as follows: First find the cross-sectional area of the stay and multiply the result by the allowable stress per square inch.

Thus, 1⅛ × 1⅛ × 0.7854 × 6,000 = 5,946 pounds.

Stress Allowed on Unwelded Stays

According to the A. S. M. E. Boiler Code, the allowable stress for unwelded stays for lengths not exceeding 120 diameters is 9,500 pounds per square inch; for stays exceeding 120 diameters 8,500 pounds per square inch. The allowable stress on a 1⅛-inch stay, according to the first condition, equals 1⅛ × 1⅛ × 0.7854 × 9,500 = 9,443 pounds.

For the latter condition, the allowable stress equals 1⅛ × 1⅛ × 0.7854 × 8,500 = 8,449 pounds.

To determine the required cross sectional area of a stay, first compute the total load on the stay and divide the load by the value of the allowable stress on the stay.

Example: A plate is stayed so that the pitch is 6 inches between stay centers, the working pressure allowable on the boiler is 125 pounds per square inch. What is the required cross-sectional area of the stay, if unwelded stays less than 120 diameters in length are used?

Solution: The total load on the stay equals 6 × 6 × 125 = 4,500 pounds.

Allowable stress per square inch on hollow stay less than 120 diameters in length equals 8,000 pounds per square inch. Then, 4,500 ÷ 8,000 = 0.568 square inch.

The diameter of such a stay equals

$$\sqrt{\frac{0.56}{0.7854}} = 0.84 \text{ inch say } 7/8 \text{ inch.}$$

The formula for calculating the maximum allowable working pressure on a stayed surface is given as follows:

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

in which:

P = maximum allowable working pressure, pounds per square inch.
T = thickness of plate in sixteenths of an inch.
p = maximum pitch, inches.
C = constant, for various conditions of staying plate. (These are given in the A. S. M. E. code.)

Consider in the previous example that the plate is 7/16-inch thick, what pressure is permissible in the stayed surface?

Use the formula $P = C \times \frac{T^2}{p^2}$ and substitute the values given.

Thus, $P = 112 \times \frac{7 \times 7}{6 \times 6} = 152.32$ pounds per square inch.

The value of C = 112 for stays screwed through plates not over 7/16 inch thick with heads riveted over.

The heating surface of a boiler is considered to be that part of the boiler shell, tubes and flat plates that are exposed to the heat from the gases on one side and with water on the other side. The heating surface calculations depend on the size and type of the boiler.

Example: A horizontal return tubular boiler 60 inches in diameter, 14 feet long, has eighty 3-inch tubes. What amount of heating surface is in such a boiler?

Solution: It is customary to consider that two-thirds of the shell is exposed to the heat.

Circumference of shell = 60 × 3.1416 = 188½ inches.

Length of shell = 12 × 14 = 168 inches.

Heating surface of shell = 188.5 × 168 × ⅔ = 21,112 square inches.

Circumference of tube = 3 × 3.1416 = 9.425 inches.

Heating surface of tubes = 9.425 × 80 × 168 = 116.572 square inches.

Area of one head = 60 × 60 × 0.7854 = 2,827.4 square inches.

⅔ area of 2 heads = 2,827.4 × 2 × ⅔ = 3,769.9 square inches.

Sectional area of tubes = 3 × 3 × 0.7854 × 80 = 565.5 square inches.

Total heating surface

$$= \frac{21.112 + 116,572 + 3,769.9 - 565.5 \times 2}{144}$$

= 974.4 square feet

The value 144 is the number of square inches in one square foot.

If you will state definitely the particular examples you are having difficulty with in the bracing of boilers, we can assist you. It is advisable that you make a study of some treatise on boiler design and calculations. A boiler inspector should be able to handle such problems and interpret the various boiler rules and regulations.

Mechanism of Boiler Scale Formation

At the Pittsburgh, Pa., experiment station of the Bureau of Mines, a study is being made of the mechanism of scale formation in steam boilers, including the effect of temperature, pressure, character of surfaces, and concentration of the water. At the present time a continuous test is being conducted on a commercial boiler in actual operation, in which a part of the suspended matter is being continuously removed by an external filter through which the boiler water is circulated. A complete record and account of the scale forming constituents is being kept and the influence of added constituents is being noted.

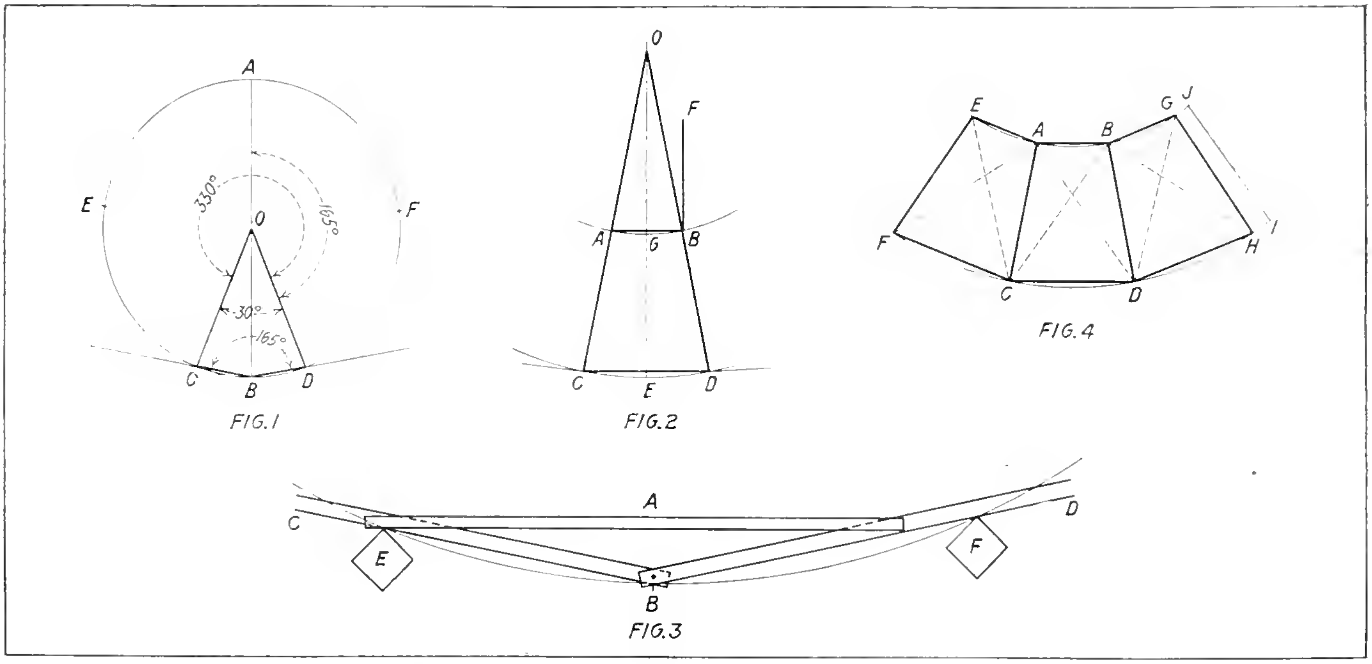
Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

The Camber Line in Laying Out Problems

Articles have been published from time to time on the laying out of taper cylinders having so little taper that it is difficult to make the arcs which go to make up the bases, top and bottom of the cylinder.

The term generally used in connection with such problems is "the camber line." Many other readers have given their best rules on camber layout and all seem to be very good, too. The one given here may still win recognition by readers of The Boiler Maker however.



Principles Employed in Laying out Cambered Bodies

In Fig. 1 I have endeavored to make clear the principle employed in the following article. Assuming that the angle, *OCD*, Fig. 1, is 30 degrees and is bisected by the line, *AOB*, the arcs, *A-F-D* and *A-E-C* each of 165 degrees, would result. If we draw straight lines through *B-D* and *O-D*, Fig. 1, the angle thus formed will also be 165 degrees. This is easily determined, because the sum of all the angles in *OCBD* must be 360 degrees. Subtracting 30 degrees we get 330 degrees. Half of this is 165 degrees.

This is made more clear by reasoning that if the four equal angles at *C*, *B* and *D*, will total 330 degrees, then two of the angles measure half as many degrees, or 165. This holds good no matter where the point *B* would be located on the arc *CBD*, so far as the angle formed by lines *CB* and *BD* are concerned. Therefore, we could make the arc by sliding the tool shown in Fig. 3, the use of which we will endeavor to explain later, across arc *CBD*.

Fig. 2 is drawn to represent the elevation of a tapered cylinder, in which *AB* is the upper base, and *CD* is the lower or larger base. Now if the point *O* were beyond the reach of the trammel, or whatever tool is used in common practice to make arcs, then it would be a case for the method herewith explained.

In Fig. 2 *OE* bisects the figure *ABCD*, and line *BF* is drawn at right angles to *AB* at point *B*. This gives the same result in the angle of the lines, *BF* and *BD* at *B*, as when making the whole circle to get this angle, as in Fig. 1, where the angle was 165 degrees.

Thus in Fig. 2 the angle at *B* is equal to the angle at *E* and it still remains the same angle, no matter where the point *E* is located on the arc *CED*. When turning out jobs of this kind, we often have to make the circle in a number of pieces, so the figure is always made to the full size of the side elevation, that is, "diameter sizes and not circumference," to make the required arc. Then to get the pattern out, take the diameter multiplied by 3.1416 for each respective end. Divide this by the number of pieces that it takes to make the course or ring, then measure half each way on the arcs from the points *E* and *G*, Fig. 2, to get the required length of the respective ends. The side elevation would make a little less than a third of the full ring.

Instrument for Drawing Camber Lines

To proceed to use the tool described in Fig. 3, take two straight edges, or straight wooden strips, each longer than the large diameter of the work in hand. *CB* and *BD*, Fig. 3, are the strips required. Bolt them together at *B* about 2 inches from the end of each stick. Lay this apparatus upon the lines *FB* and *BD* in Fig. 2, making it come to the same angle and keeping the points *B* together in each case. Then with a third stick, shown at *A* in Fig. 3, nailed across to keep the angle from changing, we can go ahead with the work. The squares at E and F, Fig. 3, represent two square cornered blocks of iron used as holding points. By placing a pencil in the corner of the sticks at B and keeping the sticks pressed against the iron blocks E and F, Fig. 3, it will scribe the arc while the tool is moved across by sliding the point B from block E to block F.

By placing these blocks at points C and D, Fig. 2, and then proceeding as explained above, we can make the arcs CED and also placing the blocks at A and B, Fig. 2, we can make the arc AGB without changing the set of the sticks. It can be seen that all this could be done without the use of the point O, in Fig. 2.

When the cylinder can be made in one piece, the work is done as in Fig. 4. The side elevation is drawn up as before and all the work carried on as explained. Then join on like figures or side elevations on each side of the center section as $ABCD$, Fig. 4. The other side elevations are treated with the same operations as before and the lengths of the arcs $EAGBJ$ and $FCDHI$ are measured by taking 3.1416 times the small diameter from E to J on the small arc and the large diameter times 3.1416 gives the length from F to I on the larger arc.

Types of Joints Used

If the joints are to be lapped the lines are used for rivet holes and the lap added. For butting joints together cut on the lines as no thickness allowance need be considered. This would be necessary in a real job, and could be easily taken care of by always using neutral dimensions both in the drawings and in making calculations.

Trammeling off the lengths in Fig. 4, to join on the side elevation on each side can be done easily by assuming that all the dotted lines, which are the diagonals are the same length, and can be trammeled off by triangular methods that are known to all layout men and need not be explained here, the strange part about this tool is that it makes an arc of smaller radius without being changed, but this is due to the blocks being different distances apart in each case.

Columbus, Ohio. PHIL NESSER.

The Part Materials Play in Building Safe Boilers

(*Continued from page 122*)

the delivery tube is detached and 2 cubic centimenters of starch indicator added, as well as a 30 cubic centimeter concentrated solution of hydrochloric acid. The mixture is titrated to a blue color with potassium iodide iodate solution. One cubic centimeter of the latter should equal 0.001 percent sulphur in a 5 gram sample of iron or steel, according to the solution used at the Works.

Checking the Phosphorus Content

A 2 gram sample of the steel to be tested is placed in a 350 cubic centimeter flask and dissolved in 50 cubic centimeters of nitric acid. When the solution is complete a few cubic centimeters of a saturated solution of potassium permanganate are added. This mixture is boiled for 3 minutes and the excess reduced with ammonium bisulphite solution. This is boiled until the brown precipitate of manganese dioxide becomes clear. The excess bisulphite solution is boiled off and allowed to cool to 70 degrees C. Add 40 cubic centimeters of ammonium molybdate solution and shake for 5 minutes. Filter and wash until free from acid and return the mixture to the flask. Dissolve in excess standard sodium hydroxide solution. Add a few drops of phenolphthalein and titrate excess sodium hydroxide with a standard nitric acid solution. It should require one cubic centimeter of standard sodium hydroxide solution to equal 0.01 percent of phosphorus in a 2-gram sample.

Manganese

Weigh out 0.2 gram of iron or steel and transfer it to a 150 cubic centimeter Erlenmeyer flask and dissolve in 25 cubic centimeters of nitric acid. Boil until the sample is dissolved. Add 40 cubic centimeters of silver nitrate solution, then 15 cubic centimeters of ammonium persulphate and heat until fine bubbles begin to rise. Cool and add 10 cubic centimeters of sodium chloride solution and titrate with sodium arsenite solution. One cubic centimeter of this solution is equal to 0.0002 gram of manganese.

Material Storage Yard

When plates are found to be defective in production or develop defects in working, replacements are made from stock. This material is checked very carefully and made to meet the exact requirements of the original material. It is inspected for defects that it may have developed in manufacture and for any that might have resulted from its storage —such as corrosion. In addition, it is watched closely all through its fabrication for the possible development of flaws in working.

All steels are segregated in the storage yard, so that it is possible to locate either special orders, or material having certain specifications, very readily. The saving in time made possible by carefully systematizing the storage yard can hardly be overestimated.

OBITUARY

WILLIAM A. BURNHAM, president Burnham Boiler Corporation and of the Lord and Burnham Company, died at his home in Irvington, N. Y., on April 19, in his 77th year. He was also prominent as a banker.

JOSEPH H. MCNEILL, Chief Inspector of the Hartford Steam Boiler Inspection & Insurance Co., died suddenly at his home, Irvington-on-Hudson, April 18, 1923, of heart failure.

He was born Feb. 14, 1865, in Charlottetown, Prince Edward Island, where he received his education in the public schools and in the Prince of Wales College. In his early life he was connected with the Prince Edward Island Railway, and he held the position of chief engineer of ocean-going vessels under licenses both from the United States government and from the British Board of Trade, and for several years was an engineer officer of the Eastern Steamship Co., sailing out of the port of Boston. Later he was engineer of the New England Piano Co. at Cambridge, and of the Hood Rubber Co. at Watertown, Mass. He left the latter company in 1898 to enter the service of the State of Massachusetts as a boiler inspector of the District Police of the Commonwealth of Massachusetts. About ten years later he became chief inspector and chairman of the Massachusetts Board of Boiler Rules. In both capacities he had much influence in shaping the laws and rules governing the construction, installation and operation of boilers.

Mr. McNeill resigned from the Massachusetts State Inspection Department on July 8, 1912, and became Chief Inspector of the Boston Department of the Hartford Steam Boiler Inspection and Insurance Co., in which position he remained until he was transferred to the New York office in May, 1915.

He was a member of the Board of Examiners of the Industrial Commission, Boiler Inspection Department, State of New York; A.S.M.E.; Diana Lodge A.F. & A.M., Melrose, Mass.; and Flatbush Chapter, No. 177, O.E.S., Brooklyn, N. Y.

New Staybolt Designed to Promote Flexibility

(*Continued from page 131*)

sheet are shown in Fig. 7. The plug, above, shows the position when welding before the excess rim is removed.

This example shows a maximum slope of 32 degrees. Shorter outer plug connection would be used for less acute slopes.

The top of the sloping sheet connection before and after burning off the excess rim as it will appear welded to outer sheet is shown in Fig. 8. The welding is only carried part way to show the accessibility for welding.

The possibility of driving over firebox connection without "holding-on" is demonstrated in Fig. 9. In order not to loosen or injure the thread it is essential that the threaded bolt be a good fit in the sheet before driving.

Fig. 10 illustrates the machine used for making vibratory tests of both semi-flexible and double articulated bolts. In both cases a tensile stress of about 3,100 pounds was maintained with an oscillation of ¼ inch at one end—the opposite end being held rigid; the semi-flexible bolts breaking near the rigid end in from 4,500 to 7,000 revolutions; the double articulated bolt running 128,400 revolutions without showing signs of breakage.

Tensile tests, on the latter, resulted in the bolt breaking in the "breakage point" at 51,000 pounds per square inch, while the outside diameter of the socket showed no enlargement by micrometer measurement before and after test.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

Vice-Chairman—D. S. Jacobus, New York.

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—W. E. Murray, Seattle, Wash.

American Boiler Manufacturers' Association

Annual Meeting—The Homestead, Hot Springs, Va., June 4, 5 and 6.

President—A. G. Pratt, Babcock & Wilcox Company, New York.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—F. C. Burton, Erie City Iron Works, Erie, Pa.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; C. V. Kellogg, Kellogg-McKay Company, Chicago, Ill.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Ill.; W. A. Drake, The Brownell Company, Dayton, Ohio; Alex. R. Goldie, Goldie & McCullock Company, Galt, Ont., Can.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. C. McKeown, John O'Brien Boiler Works Company, St. Louis, Mo.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Frank, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Boiler Makers' Supply Men's Association

Annual Convention—Hotel Tuller, Detroit, Mich., May 22 to 25.

President—W. M. Wilson, Flannery Bolt Company, Pittsburgh, Pa. Vice-President—George R. Boyce, A. M. Castle Company, Chicago, Ill. Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

Master Boiler Makers' Association

Annual convention—Hotel Tuller, Detroit, Mich. May 22 to 25.

President—Thomas Lewis, G. B. I., L. V. System, Sayre, Pa.

First Vice-President—E. W. Young, G. B. I., C. M. & St. P. R. R., 81 Caledonia Place, Dubuque, Iowa.

Second Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry St., Bloomington, Ill.

Third Vice-President—Thomas F. Powers, System G. F. Boiler Dept., C. & N. W. R. R., 1129 Clarence Ave., Oak Park, Ill.

Fourth Vice-President—John F. Raps, G. B. I., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.

Fifth Vice-President—W. J. Murphy, G. F. B. M., Penn R. R. Lines West, Fort Wayne Shops, Allegheny, Pa.

Secretary—Harry D. Vought, 26 Cortlandt St., New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Ave., Columbus, Ohio.

Executive Board—L. M. Stewart, G. B. I., Atlantic Coast Lines, Waycross, Ga., Chairman.

TRADE PUBLICATIONS

Taps.—The Geometric Tool Company, New Haven, Conn., has just issued a 26-page booklet which is devoted exclusively to illustrations and a description of the construction and operation of its line of adjustable collapsing and solid adjustable taps.

Production Tools.—Scully-Jones & Co., Chicago, has issued catalogue 33 outlining the advantages and adaptability of each of its Wear-Ever production tools, which include chucks, milling cutters, special tool holders, collets, etc. Practical suggestions for improvements in machine shop practice, reference data, charts and tables have also been included in this 40-page booklet.

Hoists and Cranes.—The Link-Belt Company, Chicago, has recently issued a comprehensive and instructive treatise on electric hoists and overhead cranes. The book is not only profusely illustrated with photographs of actual Link-Belt installations, but with line and wash drawings the subject of proper installation and efficient operation is fully covered. Practices and methods employed by users in widely divergent fields are also outlined.

Pipe Threading Machinery.—The Landis Machine Company, Waynesboro, Pa., has recently issued catalogue No. 24 in which its line of stationary pipe die heads, pipe threading and cutting machines, rotary pipe and nipple threading die heads, pipe and nipple threading machines, automatic die heads and chaser grinders are illustrated and described in detail. The catalogue is carefully prepared and printed, containing 75 six-inch by nine-inch pages.

Tube Cleaners.—Air, steam or water-driven tube cleaners for fire tube and water tube boilers, fuel economizers, condensers, evaporators, feed-water heaters, etc., are illustrated and described in a neatly arranged booklet of 32 pages which has recently been issued by the Roto Company, Hartford, Conn. A chart, outlining a practical method of finding the percent of fuel saved by keeping boiler tubes free from scale, is also included. The booklet is indexed so that information regarding any of the Roto tube cleaning machines can be quickly and easily located.

Arc Welding and Cutting.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently issued special publication No. 1659, in which the subject of electric arc welding and cutting is treated in a thorough and interesting manner. The booklet, which contains numerous illustrations, begins with a chapter on the reasons for organizing and standardizing the welding organization, the training of arc welders and the inspection of metallic electrode arc welds. This is followed by chapters on the principles of arc welding, the physical characteristics of arc metal, the use of the graphite electrode, and cost and application data. Several pages are then devoted to a brief description of Westinghouse arc welding apparatus.

Machine Tools and Cranes.—In a large, well illustrated booklet entitled, Recent Developments in Machine Tools and Cranes for Railroads, Manning, Maxwell & Moore, Inc., New York, describe improvements in some of its more important products used by the railroads. Comparatively dull years since the armistice have been used in changing designs and patterns so that with the improved equipment shopmen can obtain maximum production with minimum physical effort. First position in the booklet is given to the Putnam wheel lathes which are followed by heavy duty car wheel borers, axle lathes, boring mills, slotters and other standard tools handled by the company. Several pages are devoted to shop crane, steam hammers, wheel presses, punches and shears, flue welders, staybolt threading, radius grinders and other shop machines.

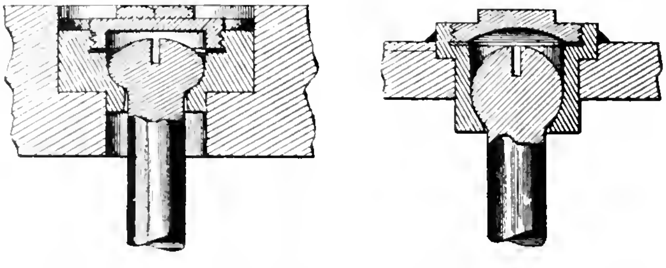
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,447,068. STAYBOLT STRUCTURE FOR BOILERS. JOHN ROGERS FLANNERY, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

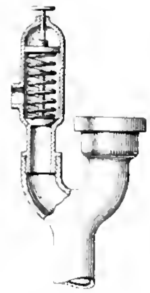
Claim 1.—In a staybolt structure, the combination with a boiler sheet provided with an opening having portions thereof differing in diameter whereby an annular shoulder is formed between the planes of the respective



faces of the sheet, of a mounting for a staybolt having parts different in diameter located in said opening, the part of said mounting having the greater diameter resting upon said annular shoulder in the boiler sheet and welded to the latter, a staybolt having a head seated in said mounting, and a removable closure engaging said mounting over the head of the staybolt. Three claims.

1,429,296. AUXILIARY PRESSURE-RELIEF DEVICE FOR STEAM BOILERS. CASIN W. OBERT, OF MOUNT VERNON, NEW YORK.

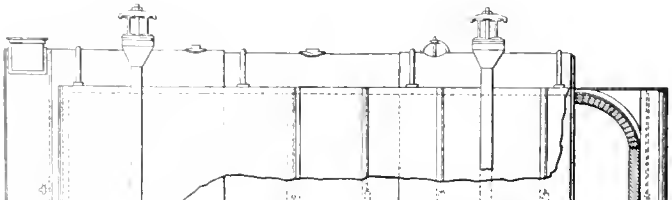
Claim 1.—In a pressure device, a branch pipe having a relief valve in one branch of the pipe, a rupturable diaphragm in the other branch, cush-



ioning means for engaging the diaphragm at its edges, and means for confining the diaphragm and the cushioning means in the pipe branch. Two claims.

1,446,937. BRIDGE-WALL FOR BOILERS. PATRICK J. SHANAHAN, OF NEW ORLEANS, LOUISIANA.

Claim 1. In means for the purpose set forth, the combination of a boiler, a fire box arranged beneath the forward end of the boiler, an inclined wall formed in rear of the fire box and sloping upwardly toward the



boiler, an inclined wall pitched upwardly toward the rear of the boiler and abutting an arch wall in rear of the boiler, and a bridge wall formed at the forward end of the last named inclined wall and abutting against the upper end of the inclined wall that is arranged in rear of the fire box; said bridge wall terminating slightly below the boiler, and adapted to surround the sides and bottom of said boiler.

THE BOILER MAKER

JUNE, 1923

Fig. 1.—One of the 2-8-2 Type Boilers Coming Into the Boiler Shop

Boiler Repair Methods at Columbus Shops

Without the all around boiler maker of former years, the railroad boiler repair shops throughout the country are facing a problem that requires immediate solution if the increasing demands for power are to be met. The Pennsylvania Railroad shops at Columbus, Ohio, have found one method of accomplishing excellent results in boiler and locomotive maintenance even under the present difficult conditions of finding trained men. Details of the plant and some of the work done at Columbus are given below.

As in other lines of industry, specialization has begun to find a field in the boiler shop. At least the operation of the boiler repair department of the Pennsylvania Railroad at Columbus, Ohio, would indicate that the system can be operated with a great degree of success. With a nucleus consisting of a well-trained master boiler maker, an assistant, a foreman boiler maker, a supervisor, inspectors and an experienced layerout, an organization has been built up here which not only functions efficiently but which is gradually accomplishing a repair record that few shops in the country are able to equal.

Production is gradually being developed so that within a short time about 75 heavy repairs will go through the shop a month. Of these, about 20 will be class 2 or complete firebox repairs and the remainder half and three-quarter side sheets and other miscellaneous boiler and mechanical repairs. Approximately 325 men in two shifts will be employed turning out this work,—a day shift consisting of about 250 men and 75 on the night shift.

Production at present with 275 men is 60 repairs a month. This is being accomplished as previously indicated with a few well-trained department heads and with men who are being trained in the various special operations of boiler work that the old-time boiler makers combined in their general knowledge of the trade. This specialized operation system, however, has the advantage of speed and the comparatively rapid development of skill in the limited scope of work performed by an individual. The plant equipment is complete and facilities for performing the required operations are of the best—this equipment and some of the methods which have met with success are outlined below.

The Boiler Shop and Equipment

The main boiler shop is placed in a north and south direction and is at the west end and at right angles to the main erecting shop. The entire plant is of brick and steel construction with modern steel window frames providing a maximum of natural light to the shop. At the south end

Fig. 2.—Corner of the Layout Section, Looking Across the Main Shop

of the main boiler shop, as indicated in the accompanying floor layout, is located a 150-ton 15-foot gap pneumatic bull riveter served by a 50-ton floor controlled electric crane. This crane having a span of about 35 feet runs transversely of the shop but is within range of the main shop crane so that it is able to pick up a boiler to be riveted from the floor and control it through the riveting operation. This crane is operated on 230 volts direct current. The main hoist motor is of 50 horsepower, the trolley travel is 15 horsepower and the bridge travel 35 horsepower.

In the main section of the shop the crane used runs the entire length and has the following characteristics: The capacity of the crane is 60 tons and it is operated on 220 volts direct current; the main hoist motor has a rating of 50 horsepower; the auxiliary hoist motor, 25 horsepower; the main trolley travel, 10 horsepower; the main hoist of the auxiliary trolley is 50 horsepower; the auxiliary hoist, 25 horsepower; the auxiliary trolley travel, 10 horsepower, and the bridge travel, two 35 horsepower motors.

At the west side of the shop is a bay containing a laying out floor, flange fires, punches, shears, rolls, drills, staybolt machines, etc., which constitutes the machine tool section of the boiler shop. This department is served by a 10-ton crane using 220-volt direct current; the main hoist motor is of 25 horsepower, the trolley travel 5 horsepower, the bridge travel 25 horsepower. At the north end of the shop are located the offices of the master boiler maker and his assistant, the time offices, small tool room, locker and wash

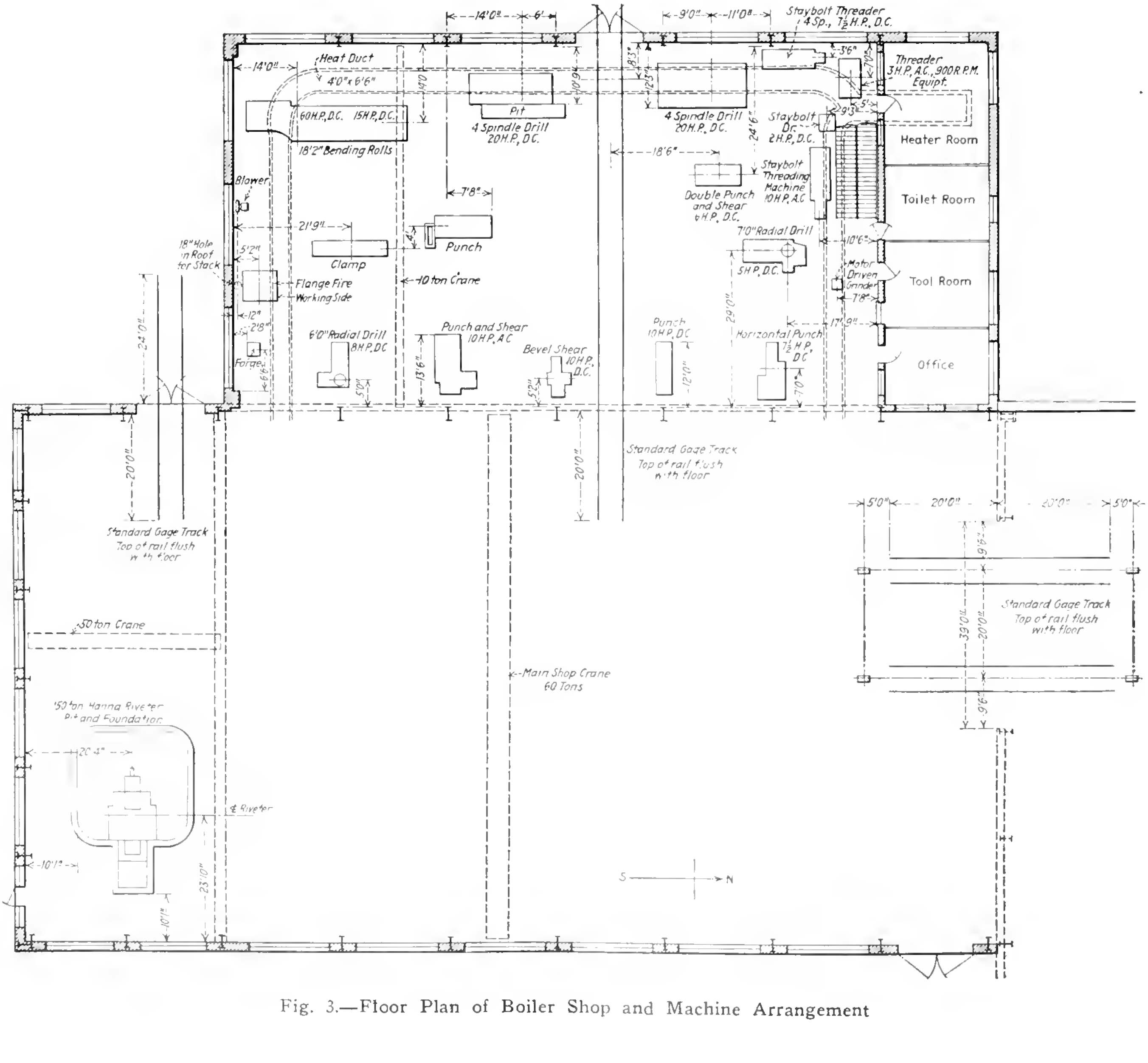


Fig. 3.—Floor Plan of Boiler Shop and Machine Arrangement

rooms and heater room; the entrance into the erecting shop is also at this end.

Machine Tool Equipment

The machine equipment in the shop, as noted, is complete, all work necessary to boiler repairs being carried out here with the exception of flanging new throat sheets. Work of this character is done on the presses at the Altoona Works of the Pennsylvania System. Punches and shears of various types, both for straight and bevel work, are provided, as well as a complete radial drill equipment. The details for these machines are indicated on the floor layout. A set of 18-foot 2-inch bending rolls is provided, two 4-spindle drills, a 7½-horsepower 4-spindle staybolt threading machine is included in the equipment as well as a 10 horsepower machine with six heads, two double heads, one for turning crown stays and the other for threading at the same time, so that both bolts are threaded and turned in a single operation. The remaining four heads are used for threading staybolts. This machine will turn out 60 crown stays an hour and 120 staybolts under the control of one operator.

Production Possibilities with Shop Layout

An absolutely clear floor space is provided in the main section of the boiler shop in which to carry out the boiler repair operations, all machine work being done in the machine bay and the shell riveting at the south end of the shop. The boilers requiring heavy repairs are stripped on the erecting floor and mounted on horses on the boiler shop floor where

Fig. 5.—Machine Operations Are Carried Out in Side Bay, Leaving Main Bay Clear of Machinery

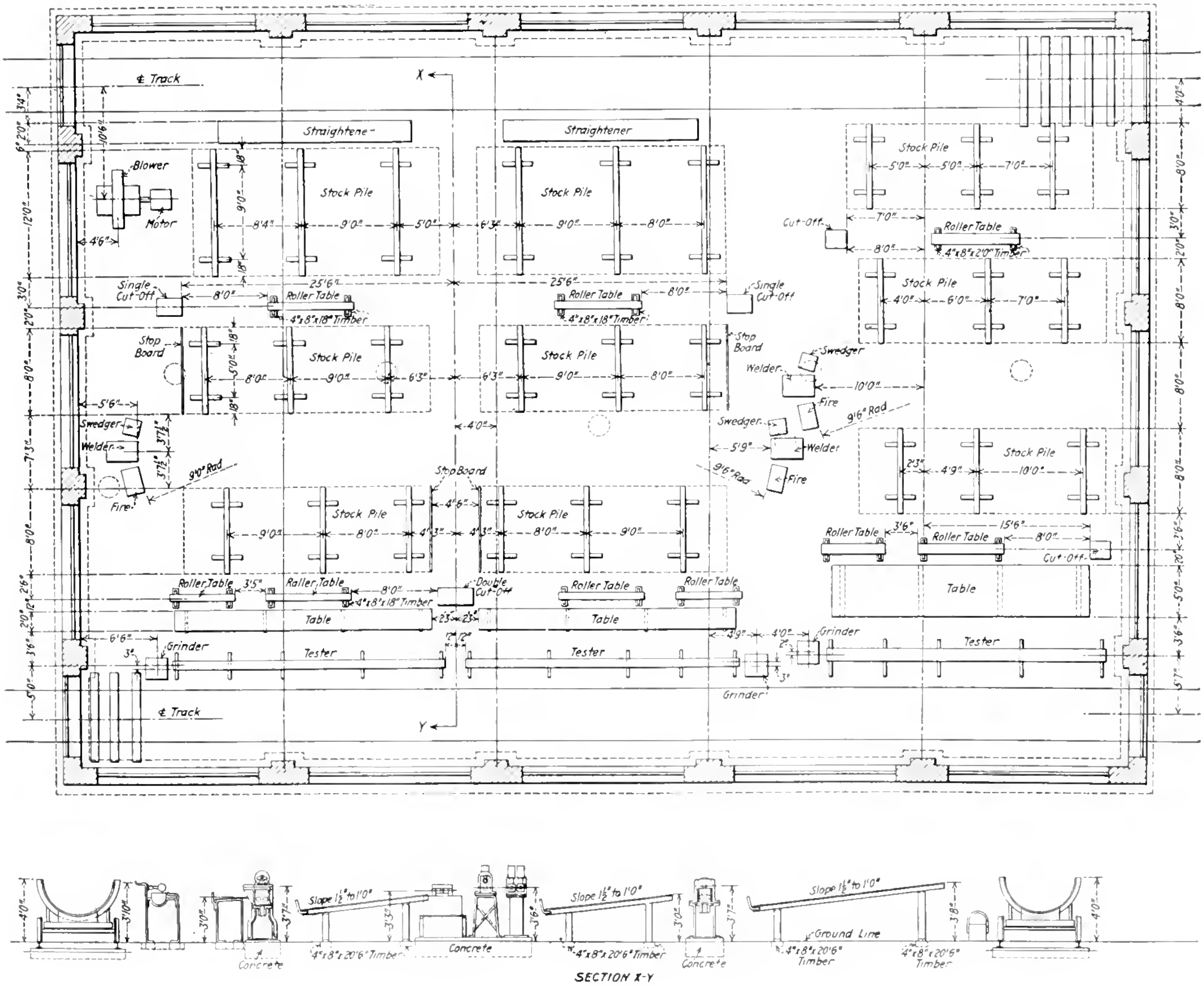


Fig. 4.—Machine and Production Details of Flue Shop

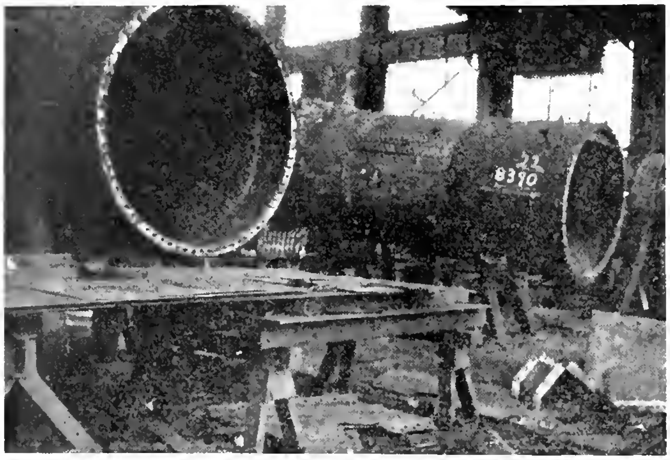


Fig. 6.—Method of Supporting Boilers During Repairs

work is carried on without interference with other operations. The space is sufficient for about 12 of the larger *L* or *N* type boilers to be worked on the floor at the same time.

Maneuvering Boilers Into the Shop

It may be well to introduce the details of shop procedure with the problem of bringing boilers into the boiler shop from the erecting floor. That this originally was a real problem may be understood when it is recalled that boilers on the erecting floor are in an east and west direction while the boiler shop runs north and south. Thus all boilers have to be turned at right angles to their original position when brought into the boiler shop. The opening between the two shops is 39 feet between columns and some of the boilers which are required to be brought through this opening run up to 45 feet or so in length. The solution found for this difficulty is simple and effective.

A boiler is carried by the main erecting shop crane close to the opening into the boiler shop. The front end is lowered onto a special turntable mounted on a small heavily built truck running on a set of standard gage tracks into the boiler shop. The rear lift of the erecting shop crane swings the rear end of the boiler so that it is heading into the boiler shop; then the crane is used to push the boiler, the front end of which is resting on the truck, through the opening into the boiler shop. A second truck support is wheeled under the rear end of the boiler which is then lowered into place within reach of the boiler shop crane. The entire operation and transfer from one shop to the other requires less than 3 minutes.

Small Details Not Overlooked

Various minor details of shop management and arrangement, tending to promote efficiency and speed up the work, are incorporated in the general scheme of things. For example air for tools is piped to every column in the shop, the lines terminating in manifolds having 9 outlets. Thus no matter in what section of the shop air is required or how many tools within certain limits are needed on a job, an opportunity is given every man to tap into the air line. For electric motor-driven tools and welding outfits convenient current outlets are provided throughout the shop.

One feature that is overlooked in many shops is the time and space saving possibility of providing standard tool boxes for individual tools which belong personally to the men. Here at Columbus, instead of carrying a miscellaneous assortment of tool boxes into the shop where they are employed and tying up wall space with them, the men are given steel lockers which are used for this purpose. These lockers are each about 32 inches long (64 inches for double lockers) and are ranged in cabinets along otherwise unused portions of the shop wall.

Small tools that are the property of the company—pneumatic and electric equipment, drills, jigs, gages and the like, are kept in the tool room where a constant check is maintained on them. One man is kept busy repairing air tools.

Flue Shop and Equipment

The flue shop is located in a separate building adjacent to the boiler shop. Two motor-driven wet rattlers mounted on a cleaning platform are located just outside the flue shop. These rattlers are served by an overhead electric crane so that as the tube bundles are brought on to the platform on special trucks they are picked up in chain slings and deposited as a unit in the rattlers. This does away entirely with the time wasting method of hand charging. In unloading the rattlers, the entire charge of tubes is dumped on to suitable bent rails or angles in shallow pits adjacent to the rattlers where the chain slings may be readily adjusted around the tubes. The crane then deposits them in the tube buggies and they are wheeled into the shop. As noted on the accompanying floor layout, sets of standard gage tracks run along each side of the flue shop entering at the corners so that they serve every part of the plant and are used either for bringing the tubes in for reconditioning or for removing them after safe ending into the erecting shop.

The layout of the flue shop also indicates the departments into which it is divided, and the equipment installed for

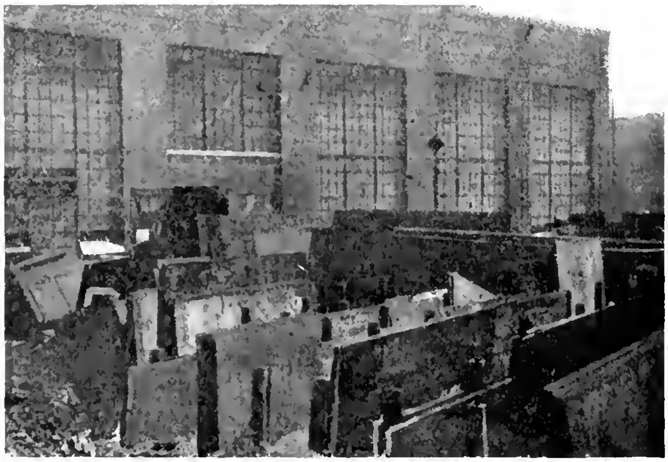


Fig. 7.—Plate Storage Adjacent to Boiler Shop

safe ending small tubes and superheater flues. Both departments are quite distinct so that no interference occurs between the crews working on different size flues. Roller welding machines are used and oil fired furnaces are installed for heating.

It is customary to test each tube after safe ending and new hydrostatic testing units are now being installed in which the tubes are subjected to about 300 pounds' pressure. Three welders and their helpers handle the safe ending—turning out about 600 small tubes and 50 superheater flues a day.

Flue practice standard with the Pennsylvania System is followed in this shop; that is, the method of safe ending, the number of safe ends, lengths, etc.

So far as possible, locomotives on which repairs are contemplated are scheduled far enough ahead so that whatever plates or special fittings are to be used may be ordered and ready for the locomotive when it comes into the shop. A supply of plates and other materials is kept in stock

(*Continued on page 185*)

Boiler Manufacturers Meet at Hot Springs, Va.

Thirty-fifth Annual Convention of American Boiler Manufacturers' Association, June 4 to 6, Well Attended — Abstracts of Papers and Discussion

Members of the American Boiler Manufacturers Association began to assemble at The Homestead, Hot Springs, Va., on Saturday, June 2, for the thirty-fifth annual meeting of the association which was scheduled to open on Monday morning, June 4, for a three days' session. Preliminary to the regular meetings the executive committee held a meeting in the Secretary's rooms at 8 P. M. on June 3.

Shortly after 11 o'clock on Monday morning A. G. Pratt, of the Babcock & Wilcox Company, president of the association, called the convention to order in the theater of the hotel and delivered his annual address, which in part was as follows:

Abstract of President's Address

The past year has been one of varying emotions, during which we have hoped and worked for and seen improved business conditions, and now that the period of better business has arrived, we are perplexed to know how long it will last, and have become cautious concerning the future.

This is not only natural but proper considering the conditions which this better business have brought about: pyramiding of material prices, the difficulties in obtaining materials, high wages, and difficulties in obtaining labor. The material supply is becoming somewhat easier and it is probable that maximum prices have been reached, but the difficult labor situation will undoubtedly continue throughout the present business cycle.

While no one can predict the immediate future with certainty, some very comforting facts appear to be pretty definitely established. It seems inconceivable that business can fall to the depths reached in the latter half of 1920 and in 1921; there is no over-extension of credit; corporate, as well as governmental finances are in satisfactory shape and the banks are in good condition: there is and has been little if any production in excess of requirements; stocks of all commodities are low; and many improvements, public and private, are merely held up until they can be undertaken without bidding against today's necessities. While the present high rate of production may not be maintained there appear to be many legitimate outlets in sight for American manufacturers for a long time to come. As a matter of fact, what we desire, and that which is best for the community, is good business, not periods of tremendous activity, which are always followed by periods of depression.

Taxes

The question of taxes is still a most important one to industry of every character. While the Government has made good headway in reducing expenditures in certain quarters, it seems certain that an attempt will be made to revise the tax laws at the session of Congress which meets in December next. While it is, of course, true that up to six or seven years ago this country never had any really great tax problems, it is to be hoped that a definite tax policy may some day be adopted which will be adhered to, rather than subject the nation to constant changes in the laws which makes planning ahead difficult and uncertain.

It appears probable that Congress will attempt to pass bonus, immigration, railroad and tariff legislation and that government ownership and regulation of certain industries will come in for considerable discussion. Past experience shows, however, that the national legislation rarely enacts much business in the session immediately preceding a Presidential election, and it is generally believed that this will prove the case in this instance.

Legislation has become in too many instances the result of pressure brought to bear upon the lawmakers by "blocs" or combinations of interests. I do not wish to see an industrial or a business "bloc," but I do feel that industry and industrial leaders should take a greater interest in government affairs. I do feel there should be more business in government. Possibly the present administration has done more in this respect than previous administrations but there is still room for improvement. One of the outstanding evidences is the interest of the Department of Commerce in business. This is not interest of a regulatory character but one which is calculated to benefit American industry, both at home and abroad, and through the benefit to industry, to benefit the nation at large. If business desires a greater share in government, it must do everything possible to make the work of the Department of Commerce successful so that it will become an increasingly effective business department and so that it must be recognized that business men of the caliber of the present Secretary, Herbert Hoover, must be appointed to head this department in future administrations. It devolves upon the business men of the country to see to this; unless they create the demand, the department will go backward and be as ineffective as it was for many years before Secretary Hoover took hold of it.

Scarcity of Labor

Our industry, in common with others, is suffering at present from a lack of labor, both common and skilled, although the chief shortage is unskilled labor. The increases in wages caused largely by this condition will not increase the available supply of labor. These increases can only result in extremely high rates without enabling us to obtain or hold men, decreased production through lessened efficiency of the men, and eventually a hardship on labor itself due to the higher cost of living, a stoppage of buying and the eventual lack of business and of employment.

While employers generally are demanding a revision of the existing immigration laws and many would like to see all immigration restrictions removed, labor leaders and other individuals throughout the country are insistent that the present minimum be decreased. From economic and humanitarian viewpoints I do not feel that either extreme is correct, but believe that some revision in the law should be made which will make it possible for some appreciable number of healthy, intelligent individuals to come into the country in greater numbers than at present, and I further believe that an earnest and intelligent inquiry should be made as to whether a shortage exists, what causes it and what is the best remedy. Possibly this could best be carried out by a commission appointed by the President of the United States.

We do not desire a shortage of labor, nor do we wish a large over-supply. Both conditions bring hardships to the community. What we should have if possible is a flexible supply, and the question is how best to obtain it.

One simple measure which will surely give considerable relief is the postponement of public works during times of great business activity, that is to say, when labor is scarce and hard to get, the Government should not be bidding against the industries which form the backbone of the nation's prosperity. This is going to be difficult to work out in practice as, generally speaking, government work is not as exacting nor as efficiently done as is private work; the rates of pay are higher, hours of labor are shorter and the results that must be produced are easier of attainment in public than in private work. Again, the absence of public work during times of national prosperity will insure economies in such work which cannot be obtained if the construction is done during times of abnormally good business.

Another relief measure which is receiving strong support is the stoppage of many large private building and construction enterprises throughout the country; this will release men to other industries and keep down construction costs and, incidentally, have its effect on wage rates and living costs.

I believe another answer will be found in increased production per man through better machinery and a decrease in the demand for unskilled labor through the reduction of manual handling operations. It has long been recognized that the greatest opportunity to reduce labor costs is through the reduction of handling operations and costs between machine operations, and it seems certain that the American manufacturer must learn this. Our salvation and that of manufacturers generally will come through improved machines, better methods and increased production by skilled workers; but while we bend our energies toward those ends so far as our own immediate interests are concerned, we must also appreciate that the question of labor supply is and always will be important and that a satisfactory solution should be sought and found if this country is to continue to be a prosperous manufacturing nation.

The last couple of years have brought about several developments which affect our industry possibly more than we realize and tend to increase our difficulties in the design, manufacture and operation of our products. I refer particularly to the increase in size and pressure of units which we build and the methods of firing them. These matters are of the utmost importance not only to us but to our customers and the communities in which our boilers are installed and operated, and we must give proper consideration to these new developments if we accept our responsibilities as we should.

Boilers Being Built in Larger Units

The manufacture of larger units is comparatively simple; we follow generally the same designs which have proven satisfactory in the smaller units of the past; but we must bear in mind that the smaller plants containing large units are not always as flexible as the older type of plant made up of a number of smaller units, and that the investment idle when one unit is down for any reason is higher than heretofore. Improved methods of burning greater quantities of fuel per foot of furnace width have been developed, resulting in operation at higher ratings. All of these elements necessitate better design, manufacture and operation and a full understanding of the things which go to make these up.

The increase in prime mover efficiency due to higher steam pressures and temperatures is something of which we have recently come to hear a great deal. High pressure of yesterday is considered medium or low pressure today. Above all else, a steam boiler must be safe. We cannot afford to take chances and must so design and build that there can be no question of 100 percent performance, not only for our individual good names but for the protection of the community.

Use of Powdered Fuel

We have seen some wonderful advances in the burning of fuels. Results have been obtained with mechanical stokers which a few years ago were regarded as beyond their capacities. In the last couple of years the burning of powdered or pulverized coal under boilers has become more common. Some go so far as to say that powdered fuel installations will outnumber stoker plants in the future. I personally feel that this is improbable, but the facts are that two stoker manufacturers are now selling powdered fuel equipment and several others are seriously considering doing so. Undoubtedly powdered fuel applied to steam boilers, to some considerable extent at least, is here to stay.

The burning of pulverized fuel opens up an entirely new field of trouble for the boiler manufacturer. It brings about new furnace and setting designs and conditions, and while a boiler manufacturer will not be expected to design these furnaces and settings, he will surely hear of what are assumed to be his shortcomings if troubles occur. The burning of pulverized coal under boilers is relatively new; it is spreading like wildfire. Many people will enter the field because of the opportunities it seems to present and many of these same people will be irresponsible and know little or nothing of our problems. The manufacturers of successful powdered fuel equipment will have to be careful that their engineering and practical experience does not become warped or commercialized by the competition which will spring up, and we as boiler manufacturers will have to make sure that our products are protected from improper equipment of this character.

It seems to me that we must come to the realization that we have an entirely new set of conditions to meet in larger units, higher pressures and different methods of burning fuel, and that for our own protection and the good name of our industry, the protection of our customers and the public generally, we must redouble our vigilance in every direction to ensure a safe and an orderly advance in the part which we play in these developments.

Open Versus Closed Shops

At the conclusion of his address the president introduced Mr. Homer D. Sayre, commissioner of the National Metal Trades Association, who outlined the history and development of the metal trades association and reviewed the present status of organized labor in the United States and England.

Tracing the movement of organized labor in the United States from the first strike in 1786, through the activities of the Knights of Labor shortly after the Civil War and the growth of the present American Federation of Labor, Mr. Sayre declared that the movement for amalgamation, which is opposed by Mr. Gompers, will be the outstanding feature of the labor convention in October. Although the independent unions are growing by leaps and bounds he did not believe that this country will be organized to the extent that labor is in England because in this country the employee of today is the employer of tomorrow.

Mr. Sayre was optimistic about the future of the metal trades associations which today comprise 31,000 establishments that are wholly free from labor domination. Labor in England, he said, is 90 percent organized while in the United States only 10 percent of the labor is organized and the British wage earner is only one-third as well off as the American wage earner. The real danger here, he warned, is the tendency of labor to control the government and he urged the employer, as a duty to the employe, the industry and himself to maintain an open shop.

At the close of Mr. Sayre's address, the president appointed the auditing and nominating committees, instructing them to report at the Wednesday morning session.

Report of the Secretary and Treasurer

H. N. Covell, secretary and treasurer, reported that the membership of the association consists of 72 active, 22 associate members and one honorary member. The treasury showed a favorable balance of $308.55.

S. H. Barnum, chairman of the entertainment committee, outlined the rules for the golf tournaments to be held during the convention.

MONDAY EVENING SESSION

On Monday evening the members and guests of the association assembled in the main lounge of the Casino where the president introduced Mr. G. A. Richardson, of the Bethlehem Steel Company, who delivered a short address illustrated by moving pictures showing the manufacture of plates, flanged and dished heads, charcoal iron lap welded boiler tubes and staybolt iron at the Brandywine plant of the company at Coatesville, Pa. These pictures were of special interest both because this was the first time these films had been shown and because of the unusual size and precision of the work shown.

Practices and Conditions Existing in the Industry

Following Mr. Richardson's address a series of questions concerning practices and conditions in the industry, which had previously been mailed to the members, was discussed informally.

Referring first to the raw material situation Mr. Pratt, president of the association, expressed the belief that prices had reached the top, would be lower rather than higher and that no more premium prices need be expected. Deliveries, he said, were easier.

As to the labor situation, boiler manufacturers in all parts of the country reported a scarcity of labor, particularly of skilled labor. In most cases this was due to the higher wages and more attractive conditions offered by other metal working industries such as the automobile builders or the railroads. The scarcity of unskilled labor could be traced in part to the immigration restrictions.

M. F. Moore stated that at the Kewanee Boiler Works there is no shortage of skilled labor except molders but that no foreigners are employed at this boiler shop. Here the labor conditions are ideal, he said, for young men are recruited from the neighboring farm districts, taught progressively the various shop operations and kept employed the year round on day work at relatively high wages without premiums or bonuses.

A. R. Goldie, of the Goldie-McCulloch Company, Galt, Ont., stated that in Canada conditions are different as there has not been the rush of work that has occurred in the United States and the problem has been to keep the men busy the year round.

Mr. Brink, of the American Hoist and Derrick Company, St. Paul, Minn., called attention to the apprenticeship system employed in his plant and stated that the best men in their employ are those which they have brought up themselves both in the shops and in the drawing room.

A query disclosed the fact that no closed shop was represented at the convention.

Isaac Harter, of the Babcock & Wilcox Company, described at length the welfare work carried out by his company, which is all handled by the employment department. The men are supplied to the foremen by the employment department, within certain limits of rates. If a man is discharged by a foreman he goes out through the employment department and the reasons for his discharge are checked up. In this way it is seldom found necessary to change the conditions in the shop. This balance of power he considered a marked improvement as under it the foreman is no longer omnipotent.

The company also has a physical examination department that serves to keep the men from assignments of work for which they are physically unsuited. This system has shown the doctor to be a very valuable asset to the plant for he comes into a relationship with the men that no other man can have. A mutual aid association, controlled by the men, is maintained, which takes care of the health compensation among its employes; the accident cases are taken care of by the state compensation laws. The company carries group life insurance for the employes.

Discussion of the insurance question showed that there is a tendency to favor insurance in which both the company and the men share in paying the premiums.

In discussing difficulties in the manufacture of boilers it was disclosed that trouble is frequently experienced in obtaining drawings of apparatus to tie up with the boiler. In the case of trouble with the operation of boilers it appeared to be the general opinion that the manufacturer should give the services of a field engineer to the customer for two or three times but for any trouble developing after that the customer should be willing to pay at least the expenses of the field engineer.

In discussing the loss of repair part business to local foundries, competitors, etc., A. G. Pratt, president of the association, urged manufacturers to make a drive to secure orders for repair parts, not only because it would eventually mean a considerable item of business for them, but on the other hand no manufacturers should be held responsible for the performance of equipment, parts of which have been supplied in the way of repairs by parties other than the original manufacturers.

One nuisance with which the boiler making industry is afflicted today is the great number of requests received from appraisers for information regarding details, drawings and prices of completed contracts. It was the opinion of those present that when such requests come from the customer direct the information should be given free but that when it comes from appraisers a suitable fee should be charged for the information.

TUESDAY MORNING SESSION

On Tuesday morning the program comprised the presentation for discussion and adoption of reports from the following standing and special committees:

Membership

H. N. Covell, Lidgerwood Manufacturing Company, chairman, reported the loss of one and the addition of two members during the past year.

A. S. M. E. Code and American Uniform Boiler Law Society

E. R. Fish, the Heine Boiler Company, chairman, reported progress.

Ethics

F. C. Burton, Erie City Iron Works, chairman, read a copy of the Tile Makers Association Code of Ethics as best adapted for the boiler manufacturers' association and this report was referred back to the committee to be re-drafted.

Standardized Ratings of Steam Boilers

Prior to the February meeting, the committee sent out a questionnaire to the entire membership of the association, and a summary of all the replies was given in our preliminary report on February 12. The following is therefore recommended for final action:

(1) *Question*—Define the basis of boiler ratings, i.e., horsepower or square feet of heating surface.

Your committee wishes to recommend that all specifications and other data pertaining to the subject of "boiler horsepower" be specified both on a square-feet-of-heating-surface basis and also on a horsepower basis, and that preference be given to the square-feet-of-heating-surface basis if any preference be given.

(2) Your committee recommends that for all types of

boilers, ten (10) square feet of heating surface constitutes a horsepower.

(3) Your committee recommends that heating surface shall be calculated in the manner outlined in the A.S.M.E. Power Test Code, which reads as follows:

"Heating surface for boilers comprises the total area of surface in actual contact with hot gas and below the normal water level of the boiler, provided the heating surface comprises a part of the circulation system of the boiler proper. If any such surface is not in the boiler circulation system, and is not connected to the steam space of the boiler, it is to be considered as preheater, or integral economizer surface, and not as boiler heating surface. Superheater surface is the total area of all surface in contact with the hot gases. Superheater, boiler and preheater surfaces should be separately stated. Since the gas side of the surface offers the controlling resistance to heat transmission, the surface will be figured on the outside diameter of tubes for watertube boilers, and on the inside diameter for firetube boilers."

(4) Your committee wishes to bring to your notice that the A.S.M.E. Power Test Code specifically states that superheating surface, boiler heating surface, and pre-heating surface should be separately stated, and the committee therefore recommends that in all specifications this rule be followed.

We also wish to call your attention to the fact that in calculating the heating surface of watertube boilers, the *outside* diameter of the tubes should be used, and for firetube boilers, the *inside* diameter of the tubes.

(5) We recommend that for plain vertical firetube boilers, the rule be adopted that in calculating the heating surface of same, the normal water line or center of the gage glass be taken as the top point of the heating surface, and that only such surface of the shell and tubes as is below the center line of the water glass be calculated as heating surface.

(6) Your committee would recommend that in calculating the heating surface of return tubular boilers, only one-half the circumference of the shell be calculated as heating surface on account of the brick walls closing in on the boiler at a point about half way up on the shell. Your committee understands that some boiler builders calculate two-thirds of the shell as heating surface.

At the midwinter meeting, Mr. E. C. Fisher, of the Wickes Boiler Company, pointed out the fact that three sizes of tubes are used in a 72-inch by 18-foot return tubular boiler—the diameter of the tubes depending upon the part of the States in which the boiler was built. Some manufacturers have standardized on 70 4-inch tubes, which would give a total heating surface in a 72-inch by 18-foot boiler of 1,594 square feet.

The same diameter and length of shell containing eighty-six 3½-inch tubes would have 1,645 square feet heating surface, and the same boiler with one hundred and ten 3-inch tubes would give 1,760 square feet heating surface.

Practically all of the builders of the 72-inch by 18-foot boiler specify same in their catalogue and specifications as 150 horsepower regardless of which diameter of tubes is used.

W. C. CONNELLY, Chairman.

DISCUSSION

The discussion of this report emphasized the advisability of rating boilers according to the number of square feet of heating surface rather than on the horsepower.

The report was adopted.

Height and Diameter of Stacks

The engineering committee of the Stoker Manufacturers' Association submitted a report to that association on November 28, 1922, which included the following statements and recommendations:

Stack Diameters and Heights: It would be desirable if the boiler and stoker manufacturers could agree on some common formula or rule for the determination of both diameter and height so as to present a united front to contractors and owners on the question of dimensions of stacks. It was decided that this matter was one that should be referred to the joint committee of the boiler and stoker manufacturers' associations.

Draft Over Fire: Inasmuch as the effect of pressure at the top of a high furnace is something that directly affects the boiler manufacturer and only indirectly the stoker manufacturer, it was decided that this matter should be referred to the joint committee of boiler and stoker manufacturers' associations.

A meeting of the joint committee was held in New York March 20, 1923, at which the following were present:

A. G. Pratt, The Babcock & Wilcox Company.
E. C. Fisher, The Wickes Boiler Company.
A. H. Blackburn, Sanford Riley Stoker Company.
R. L. Beers, Detroit Stoker Company.
H. E. Preston, American Engineering Company.
A. D. Pratt, The Babcock & Wilcox Company.
R. A. Foresman, Westinghouse Electric & Manufacturing Company.
S. H. Barnum, The Bigelow Company.

Stack Diameters and Heights: This subject was referred to a sub-committee consisting of E. C. Fisher, S. H. Barnum, R. L. Beers and A. H. Blackburn, and the report of that sub-committee, which has been approved by the joint committee, will be presented separately by E. C. Fisher.

Draft Over Fire: The following recommendation was unanimously agreed upon:

"That the draft over the fire should be taken as follows: On horizontal watertube boilers, midway between the heating surface of the boiler and the grate surface of the stoker. On vertical and semi-vertical watertube boilers, at a point midway between the inside face of the front wall and the front face of the bridge-wall, on a line with the top of the bridge-wall. And that the draft at this point is to be not less than 0.15-inch suction."

The committee discussed the forms of data sheets exchanged between boiler and stoker manufacturers and those present stated that as far as they could learn these forms were satisfactory to all. Since the meeting of the committee the stoker and boiler associations have checked this question with their respective memberships. While all of the companies of the two associations have not been heard from the general consensus of opinion is that the data sheets are helpful and should be continued in their present form; in fact, many companies have strongly urged that the use of these sheets be continued. Slight modifications have been suggested by some of the companies and it is recommended that these points be brought up and some conclusion reached at this meeting.

The meeting discussed the possibility of enlarging the joint committee to the extent of having represented on it fan, superheater, economizer, soot blower and similar manufacturers and it was determined that if either association felt such contact to be necessary that it should undertake to bring it about independently rather than through the joint A.B.M.A.-S.M.A. committee.

The question of rating boilers upon a square foot basis was discussed with the purpose of placing the representatives of the stoker manufacturers on record, and it was recommended by the meeting that such rating rather than a horsepower rating be used by all boiler manufacturers, with the qualification, however, that there could be no objection to boiler manufacturers also stating the rated horsepower which, however, should be based upon 10 square feet of heating surface per horsepower.

Respectfully submitted.

A. G. Pratt,
L. E. Connelly,
G. W. Bach,
S. H. Barnum,
E. C. Fisher.

In addition to the foregoing committee report Mr. E. C. Fisher, of the Wickes Boiler Company, presented a very comprehensive supplementary report, going exhaustively into the determination of the diameters and heights of stacks for steam boilers, which will be published in full in the July issue of The Boiler Maker.

Owing to the absence of Mr. Fisher on account of sickness this paper was read by Mr. Barnum.

Discussion

A. G. Pratt, Babcock & Wilcox Company, president of the association, stated that the same report had been submitted to the Stoker Manufacturers' Association and that they had adopted a resolution recommending that the tables be used but that the 100 percent rating should never be used and that the 150 percent rating be considered as the minimum.

E. R. Fish, Heine Boiler Company, called attention to the fact that the proportioning of stacks requires a lot of scientific calculations for which data are lacking and that the real stack temperatures have never been determined with accuracy. Further he pointed out that the tables and curves are based on experience only and while this makes little difference with small boilers greater care must be exercised in the case of large units. He stated that tests are to be made by the Johns Hopkins University for securing accurate data for determining the constants used in the calculations.

G. S. Barnum, of the Bigelow Company, pointed out that the primary object of the report was to take care of the small return tubular boilers. Mr. Barnum did not agree with the stoker manufacturers' recommendations.

A. G. Pratt, Babcock & Wilcox Company, stated that the charts and tables are based on experience gained principally by the Westinghouse Electric and Manufacturing Company during the past two years and that they have been used for two years with good success. He stated that the estimates are fair and the results come within safe limits.

W. C. Connelly, D. Connelly Company, believed that the 100 percent rating gives stacks of too small diameter as 34 inches is the smallest anybody uses.

The committee report was adopted and a vote of thanks extended to Mr. Fisher for his special report.

A. S. M. E. Boiler Code Sub-Committee on Rules for Inspection

This committee reported progress and it was voted to refer any further revision to the committee.

Uniform Setting Heights of Horizontal Return Tubular Boilers

This subject had been considered in conference with the Smoke Prevention Association, the secretary of which believed that the local inspectors should not have the authority to set the heights but that a standard should be established by the American Boiler Manufacturers' Association. It was moved that the association send a delegate to the meeting of the Smoke Prevention Association in Minneapolis, June 20 to 22, to urge the association to take definite action and adopt the A. B. M. A. standard. The president appointed G. W. Bach of the Union Iron Works, Erie, Pa., to act as the association's delegate at this meeting.

Steel Heating Boilers

W. A. Drake, the Brownell Company, reported that the committee had obtained considerable data but not enough from which to draw conclusions and that data sheets would be sent to members of the association at an early date. He stated that the information now available came from Government tests, etc., and that what was wanted was data from users.

National Board of Boiler and Pressure Vessel Inspectors

Two representatives of the National Board of Boiler and Pressure Vessel Inspectors presented reports on the activities of this body, Mr. Joseph F. Scott, the president, and Mr. C. O. Myers, the secretary and treasurer.

Abstract of Mr. Scott's Address

I am glad to say we are now self-supporting and will be in a position to call our national convention which is very much needed. Although it was within your power to crush an organization of this kind at its inception, nevertheless you have signified to the members of the National Board of Boiler and Pressure Vessel Inspectors by your substantial support, your sincerity in desiring uniformity, standardization and the adoption of every method that would increase and tend to improve the business of boiler making in the United States.

We have considerable room for improvement, and cooperation is needed among a few of the boiler manufacturers in certain sections of the country, but we know that eventually such manufacturers will be cooperating with the National Board or it will come to the point that the customers of such boiler manufacturers will raise the question of why such manufacturers are not cooperating with other manufacturers who are members of the National Board.

Members of the National Board have important work cut out for them. It is not only essential that steam boilers be constructed in accordance with the A.S.M.E. Boiler Code, but it is high time that necessary steps be taken so that the manufacturers of such boilers will be protected against practices prevalent among firms that are dealing in second-hand boilers. Our experience with second-hand dealers shows the necessity of registering every dealer of second-hand boilers in the country and adopting specific rules and regulations with which they must comply and providing penalties to the violators of these rules. In my mind the activities of the second-hand boiler dealers are more dangerous and should be of more concern to the heads of the State and municipal steam boiler inspection bureaus than boilers that are built by responsible manufacturers in accordance with the A.S.M.E. Code.

In nine cases out of ten a prospective customer is not acquainted with the construction of a boiler. His prime interest is in obtaining a boiler as cheaply as possible and where a boiler is offered to him as a first class second-hand boiler he will invariably purchase it depending upon some method to get around the boiler inspection laws in his particular territory. This is what the National Board of Boiler and Pressure Vessel Inspectors must stop. It is very essential therefore that representatives of the National Board draw up regulations covering the handling of second-hand boilers throughout the country. Such rules can be easily put into effect, I believe, without changing the present wording of the law under which steam boiler regulations are created. This matter should receive first consideration at the next convention of the National Board.

In checking up the number of boiler explosions as compared with the number of explosions of air and other pressure vessels, it is apparent that the latter are far more numerous than the former. The sooner legislation is enacted or laws amended covering the construction and inspection of air and other pressure vessels the sooner this danger will be removed. There is no reason why this should not be made one of the most popular sets of regulations that could be adopted throughout the country.

Abstract of Mr. Myers' Address

We have been observing very closely the inspection and stamping of A.S.M.E. Code boilers and within the last two years no case has been brought to our attention where a boiler bearing the Code symbol was not in fact a Code boiler. This is very encouraging and, upon the strength of it, my purpose will be to have the Ohio Board of Boiler Rules consider the adoption of the 1922 edition of the A.S.M.E. Code and eliminate the present Ohio Code. The Ohio law provides that a public hearing must be held when changes in the rules are contemplated and this hearing will be arranged at a special meeting of the Ohio Board just as soon as the revised edition is available.

Since the Ohio situation has been satisfactorily cleared up a number of concerns have started stamping their boilers "National Board." The work of the Board is gradually increasing, our finances are in good shape and we are self-supporting. We are accumulating a fund to take care of a National Board convention which we believe should be held as soon as possible.

At your annual meeting in June, 1922, 503 boilers were registered by 18 concerns. At that time the registration fees were revised and we reported at your mid-winter meeting in February that 2,664 boilers were registered by 26 concerns. At the present time we are pleased to report 6,387 boilers registered by 35 concerns, making a total increase for the last year of approximately 1,200 percent.

For the benefit of the boiler manufacturers who are not taking advantage of the National Board in stamping their boilers we desire to advise that the following States and cities will accept without question boilers stamped with the National Board stamp: Rhode Island, New York, New Jersey, Maryland, Ohio, Indiana, Pennsylvania, Wisconsin, Minnesota, Oklahoma, Oregon, California, Utah and Arkansas, Chicago, Ill.; Seattle, Wash.; St. Louis, Mo.; Parkersburg, W. Va.; Nashville, Tenn., and Kansas City, Mo.

It can be seen from the foregoing that the progress of the National Board during the past year has been very gratifying which is due to the support and co-operation of the officers and members of the Board, the American Boiler Manufacturers' Association, the American Uniform Boiler Law Society and the Boiler Code Committee. If indications are correct the coming months will show material gains in the strength of the Board.

American Uniform Boiler Law Society

Charles E. Gorton, chairman, Administrative Council of the American Uniform Boiler Law Society, congratulated the National Board on its excellent progress and stated that no instance had been found where a boiler stamped by a National Board inspector was not a Code boiler.

Mr. Gorton said that the Administrative Council of the Uniform Boiler Law Society believed it advisable for them to use their efforts to strengthen the boiler laws now in existence.

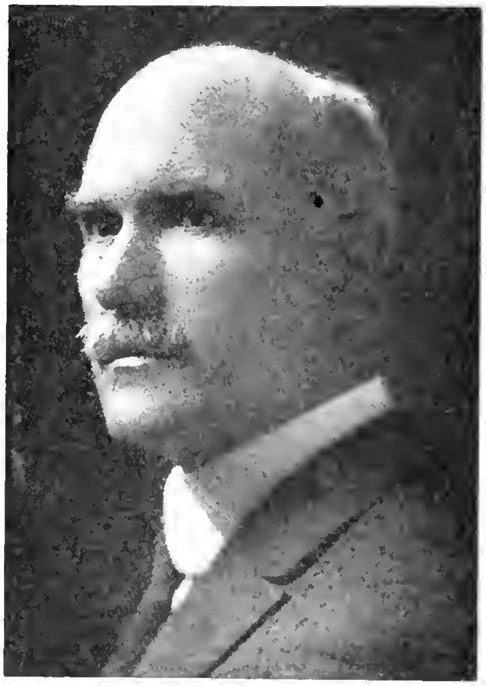
He said that they had been called in by nine states for this specific purpose. He further pointed out that 17 bills had been introduced in legislatures during the past year that were inimical to the interests of the association.

Taking up the steps which had been taken to secure legislation covering the construction and inspection of boilers in states which have not yet adopted the A. S. M. E. Code he explained the reasons why such bills had failed in Washington, Arkansas, Arizona, Florida, Georgia, Alabama, Indiana, Kansas, Iowa, Illinois, Michigan, North Carolina and Virginia. In many cases there apparently is good prospect of securing the enactment of such legislation in the near future and every effort will be exerted to secure this end.

In conclusion he declared that the Administrative Council and the Executive Committee realize that they must keep in intimate touch with the state departments or the administration of the laws will be anything but uniform.

WEDNESDAY MORNING SESSION

The final session of the convention was called to order at 9.50 A. M. on Wednesday, with A. G. Pratt, president, in the chair. Mr. Pratt called Mr. G. S. Barnum of the Bigelow Company, vice-president of the association, to the chair to take charge of the meeting during the reading and discussion of his paper on cost accounting.



E. R. Fish, President-elect of the American Boiler Manufacturers' Association

Cost Accounting

Mr. Barnum's paper will be published in the July issue of The Boiler Maker.

Discussion

A. G. Pratt, the Babcock & Wilcox Company, president of the association, did not feel that production hours are a measure of cost unless the work is uniform.

Mr. Barnum agreed with Mr. Pratt that every plant has to be governed by its own conditions and stated that the important thing is to get a cost accounting system started; at the end of a year it is possible by inventory to determine whether the system is good or not.

G. W. Bach, Union Iron Works, stated that a system installed in his plant four years ago by experts, and which required four men to handle it, proved top heavy and had been simplified so that it can now be handled by two persons.

C. W. Edgarton, Coatesville Boiler Company, explained that his cost system was based on about 15 departments, the costs of all but four of which are close together and are thrown into a general average while the other departments have a different rate and are kept independent.

A poll of those present showed that practically all are using some form of cost accounting.

F. G. Cox, Edge Moor Iron Company, spoke of the tendency to install too elaborate a system and advised making it as simple as possible.

Election of Officers

The following officers were elected to serve for the following year:

President—E. R. Fish, Heine Boiler Company, St. Louis, Mo.
Vice-President—E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.
Secretary-Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.;

W. A. Drake, The Brownell Company, Dayton, O.; A. R. Goldie, Goldie-McCulloch Company, Galt, Ont.; J. F. Johnston, Johnston Brothers, Ferryburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill., and A. G. Pratt, The Babcock and Wilcox Company, New York.

The secretary read a letter from Calvin W. Rice, secretary of the American Society of Mechanical Engineers, regarding his recent trip to South America where he found that the A.S.M.E. boiler code is held in high esteem. Mr. Rice urged the translation of the code into Spanish and Portuguese.

It was voted that the secretary reply to the above letter to the effect that the American Boiler Manufacturers Association would be very glad if the American Society of Mechanical Engineers would translate the code and suggesting that the price of the English edition be increased to cover the cost of the translation.

It was also voted that a committee of standards be appointed to get out a loose-leaf handbook containing the A.B.M.A. standards adopted by the association.

Opposes Government Ownership of Railroads

The association unanimously adopted the following resolution offered by W. H. S. Bateman, of the Parkesburg Iron Company, Philadelphia, Pa.:

Resolved that this association go on record in upholding the railroads of the United States in the fight which they are making for their very existence and that we as a body emphatically are opposed to government ownership and will use our best efforts individually to encourage public sentiment in sympathy with the railroads and will at all times endeavor to counteract the influences which are constantly working in opposition to the railroads of our country.

Entertainment Features

The annual banquet of the association was held in the main dining room of The Homestead on the evening of Tuesday, June 5. The afternoons of Monday and Tuesday, June 4 and 5, were given over to golf tournaments, the prizes for which were awarded at the annual banquet.

Registration at the Convention

The following members and guests attended the convention:

Bach, George W., Union Iron Works, Erie, Pa.
Baldwin, Frank M., Oil City Boiler Works, Oil City, Pa.
Barnum, George S., The Bigelow Company, New Haven, Conn.
Barnum, Starr H., The Bigelow Company, New Haven, Conn.
Bart, B F., Standard Seamless Tube Company, New York.
Bateman, W. H. S., Parkesburg Iron Company, Philadelphia, Pa.
Boyd, Marcus, Boiler Tube Company of America, Pittsburgh, Pa.
Brink, H. E., American Hoist and Derrick Company, St. Paul, Minn.
Broderick, J. H., Broderick Company, Muncie, Ind.
Broderick, W. H., Broderick Company, Muncie, Ind.
Bronson, C. E., Kewanee Boiler Company, Kewanee, Ill.
Brown, H. H., THE BOILER MAKER, New York.
Burton, F. C., Erie City Iron Works, Erie, Pa.

Cameron, W. S., Frost Manufacturing Company, Galesburg, Ill.
Champion, D. J., Champion Rivet Company, Cleveland, O.
Cherry, H. D., Kewanee Boiler Company, Kewanee, Ill.
Connelly, W. C., D. Connelly Boiler Company, Cleveland, O.
Covell, H. N., Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Cox, F. G., Edge Moor Iron Company, Edge Moor, Del.

Doyle, Joseph H., Ames Iron Works, Oswego, N. Y.
Drake, W. A., Brownell Company, Dayton, O.

Edgerton, C. W., Coatesville Boiler Works, Coatesville, Pa.
Edwards, J. R., Pittsburgh Steel Products Company, Pittsburgh, Pa.
Eury, J. G., Henry Vogt Machine Company, Louisville, Ky.

Fish, E. R., Heine Boiler Company, St. Louis, Mo.

Gates, R. W., Superheater Company, New York.
Goldie, A. R., Goldie and McCulloch Company, Galt, Ont.
Gorton, Charles E., American Uniform Boiler Law Society, New York.

Harter, Isaac, Babcock and Wilcox Company, New York.
Heagerty, William, Oil City Boiler Works, Oil City, Pa.

Inslee, Herbert C., Babcock and Wilcox Company, New York.

Jeter, S. F., Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.
Johnston, J. F., Johnston Brothers, Ferrysburg, Mich.

Kellogg, C. V., Kellogg-MacKay Company, Chicago, Ill.
Kirk, T. L., Standard Seamless Tube Company, Pittsburgh, Pa.

Loeb, Harry, Lukens Steel Company, Philadelphia, Pa.
Low, F. R., *Power*, New York.

McAleenan, George R., McAleenan Brothers Company, Pittsburgh, Pa.
McAleenan, Walter S., C. H. Dutton Company, Kalamazoo, Mich.
Mason, J. E., *Power*, New York.
Meier, C. R. D., Heine Boiler Company, St. Louis, Mo.
Metcalf, F. B., International Boiler Works, East Stroudsburg, Pa.
Moore, M. F., Kewanee Boiler Company, Kewanee, Ill.
Myers, C. O., National Board of Boiler and Pressure Vessel Inspectors, Columbus, O.

Pratt, A. G., Babcock and Wilcox Company, New York.

Richardson, George A., Bethlehem Steel Company, South Bethlehem, Pa.
Riley, George N., National Tube Company, Pittsburgh, Pa.

Sayre, H. D., National Metal Trades Association, Chicago, Ill.
Scott, Joseph F., National Board of Boiler and Pressure Vessel Inspectors, Trenton, N. J.
Severance, F. W., S. Severance Manufacturing Company, Pittsburgh, Pa.
Snow, Norman L., Diamond Power Specialty Company, Detroit, Mich.

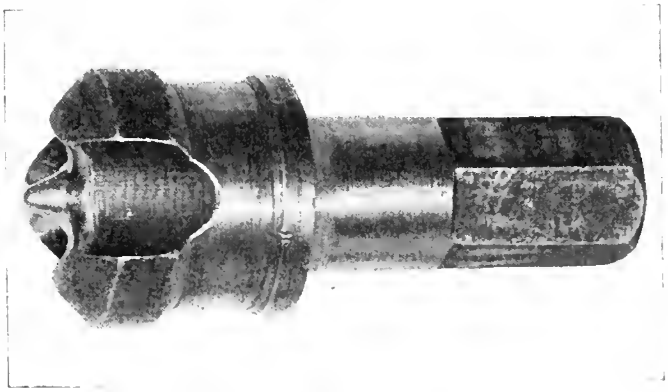
Tudor, Cliff M., Tudor Boiler Manufacturing Company, Cincinnati, O.
Tudor, Charles E., Tudor Boiler Manufacturing Company, Cincinnati, O.

Weigle, A. C., Walsh and Weidner Boiler Company, Chattanooga, Tenn.
Wein, E. G., E. Keeler Company, Williamsport, Pa.

Zycker, T. E., Gem City Boiler Company, Dayton, O.

An Improved Type of Staybolt Set

THE new "clover-leaf" staybolt set shown for the first time at the Master Boiler Makers' Association convention, is an improvement over the standard staybolt set made by the Lovejoy Tool Works, Chicago, Ill. Its unique construction is obtained by milling out approximately two-thirds of the metal from the driven surface as shown in the accompanying illustration. With it the operator is able to drive the staybolt head more quickly because only about one-third of the metal of the tool is in contact with the staybolt iron at one time. The set is driven in No. 60 to No. 90 pneumatic hammers. By turning the tool in the driving process the staybolt is headed up to the sharp points, while at the same time the ragged edges are trimmed, thus making a clean, finished job.



"Clover-Leaf" Staybolt Set

It is claimed that this set is easier to operate than the old one, as there is no tendency for it to jump all around the staybolt as in the old style. The Lovejoy Tool Works makes this rivet set from special Vanadium steel and guarantees it to give satisfactory service. It is furnished with square, round or hexagonal shank as desired, to fit any pneumatic hammer and in all sizes from $\frac{7}{8}$-inch up.

The Industrial Importance of Conserving Eyesight

EMPLOYING the methods of engineering, research in eye conservation on a nationwide scale has been undertaken by the Eyesight Conservation Council of America. The work is in charge of J. E. Hannum, a former member of the teaching staff of Purdue University, and a member of the American Society of Mechanical Engineers.

(*Continued on page* 163)

Testing Flexible Staybolts Electrically

Method Developed to Make Tests More Positive and to Remove Uncertainties of Hammer Testing

As far back as 1910 a method of testing flexible staybolts by other than the hammer had been developed by the Flannery Bolt Company of Pittsburgh, which was described at the Master Boiler Makers Association convention of that year. Again at the convention this year after seven years of experimentation and test the device was shown in its perfected state. For the past three years actual locomotive service tests have been conducted demonstrating that this method is a positive means for determining the condition of flexible staybolts in service.

In all the experiments the thought has been continually kept in mind that no method of testing that depends upon the human element can be entirely satisfactory where danger to human life is concerned. Innumerable reports can be produced to prove the uncertainty and inefficiency of the present method of testing.

Recently an authority on the subject of testing stated in an article which appeared in the March issue of the *Railway Mechanical Engineer*:

"In my opinion, in going over a boiler on a staybolt test, the inspector cannot get all the broken and cracked bolts. I have witnessed inspectors undergoing examination who are classed as good, but the results they obtained varied, some locating only one defective bolt, while others located as many as 12 or 14. Some bolts which they marked as broken or cracked were of the flexible type and were merely unseated.

"To test flexible bolts, we remove all caps and strike the head of the bolt two or three good smart blows, so as to finish the break if possible; then we take a round nose tool and strike the head first on one side then on the other, twisting it so that in case it is fractured it will break loose. I have seen several tell-tale holes leaking on hydrostatic tests, but have very seldom seen an inspector locate them while testing the bolts from the firebox side of the boiler.

"In striking a staybolt, if the hammer gives a quick rebound, the bolt is all right, but if it does not rebound and apparently sticks to the bolt, it is cracked or broken. One must not depend altogether on the rebound, but upon the sense of hearing as well; a fractured bolt gives off a dead sound and is very often easily detected by one standing close to the inspector at the time."

Description and Method

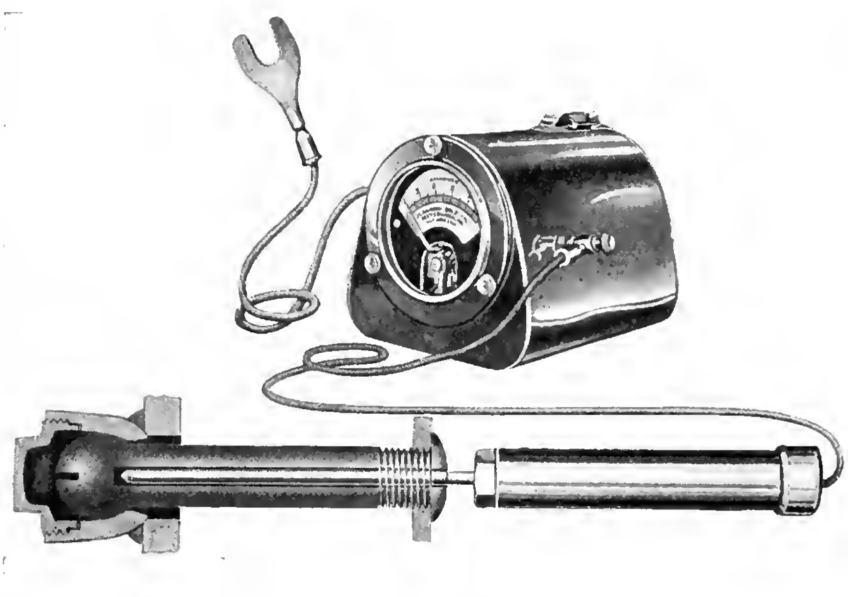
The new method of inspection requires no change in the standard parts of a flexible staybolt assemblage, with the exception of providing a bolt with a tell-tale hole extending from the inner end into, but not through, the bolt head.

Inspection is accomplished by establishing electrical contact at the extreme inner end of the tell-tale hole by means of a device consisting of a meter, batteries, an indicating rod and connection to the boiler. The apparatus is simple and compact, and requires no particular care except the occasional renewal of a dry cell battery. These are of any small popular type used commercially and can be procured anywhere.

Reference to the illustration shown herewith will probably suffice as an explanation as to how the tester works.

The connection to the boiler may be made at any point where good contact can be secured.

The indicating rod is inserted in the tell-tale hole. As soon as the tip of the rod has reached the end of the tell-tale hole the electric circuit is completed and is registered on the meter, thus insuring the tell-tale hole being open its full length and properly functioning.



Electrical Equipment for Testing Flexible Staybolts

If the indicator rod is stopped before the meter indicates contact, this would show the hole to be obstructed in some manner. In this event clean the hole by means of a drill and small motor, until contact can be established.

The method of test is quite simple and there is no phase of the test that depends upon the human element except the simple act of inserting the testing rod into the tell-tale hole.

If the bolt were fractured, this condition will be apparent in the hydrostatic test that is applied after the electrical contact has been made with all the bolts. The tell-tale holes, being clean, will immediately indicate a fracture by water leakage from the bolt that is unfit.

The basis upon which this electrical contact test has been developed is that staybolt breakage will be easily detected if the tell-tale holes are kept open and extend to every part of the bolt which can possibly break. A tell-tale hole, under this method, must extend from one end of the bolt into, but not through, the head at the other end, and therefore, covers every breakable part of the bolt. To insure clean tell-tale holes, a fireproof porous cement is provided, which is easily removed, to seal the end of the tell-tale hole after the bolts are installed and riveted.

Occasionally a mechanic may neglect to seal a hollow Tate bolt with the porous cement and in that event, a small drill should be used to bore out the tell-tale preliminary to inserting the testing rod for inspection.

If the tell-tale hole has been sealed with the porous cement, sediment, or any other obstruction that would prevent contact between the testing rod and the end of the tell-tale hole, can only come from a fractured bolt.

New Type Electric Welder for Safe-Ending Locomotive Boiler and Superheater Tubes

THE electric welding process of safe-ending locomotive boiler and superheater tubes was instituted about 1912 by the Thomson Electric Welding Company of Lynn, Mass. The welding was done on a type 40-A welder.

The electric process showed so great a saving in time and money over the oil furnace process, besides making stronger welds, that it was adopted by several of the larger railroad systems of this country and abroad.

In 1919 an extensive campaign of development was begun by the Thomson Electric Welding Company which resulted in a complete new line of resistance welders of greatly improved power factor, efficiency, operating characteristics and appearance.

The new standard 60 S. P. welder had a capacity of work of from 6 to 9 square inches which was from two to three times greater than was required for large flue welding. Hence, to avoid excessive weight, electrical and mechanical capacity, standby charges, etc., it became desirable to develop a special 60 S. P. flue welder of lighter weight, and reduced electrical capacity for this class of work. Accordingly, the flue welder shown in the illustration was standardized for locomotive work and already there are two of them in successful operation—one in the Illinois Central Shops at McComb, Miss., and one in the shops of the Duluth & Iron Range Railroad at Two Harbors, Wis.

The welder is equipped with pneumatically operated clamps having interchangeable copper dies for flues from 2 inches to 6 inches diameter. The pressure necessary to push up and consummate the weld is secured by means of a double acting hydraulic cylinder mounted directly on the welder as shown in the illustration.

This hydraulic cylinder may be operated by any one of the following methods: (1) By hand pump actuated by a lever; (2) by connecting cylinder piping direct to an accumulator; (3) by connecting the cylinder piping directly to an oil gear pump made by the Oil Gear Company of Milwaukee, Wis.

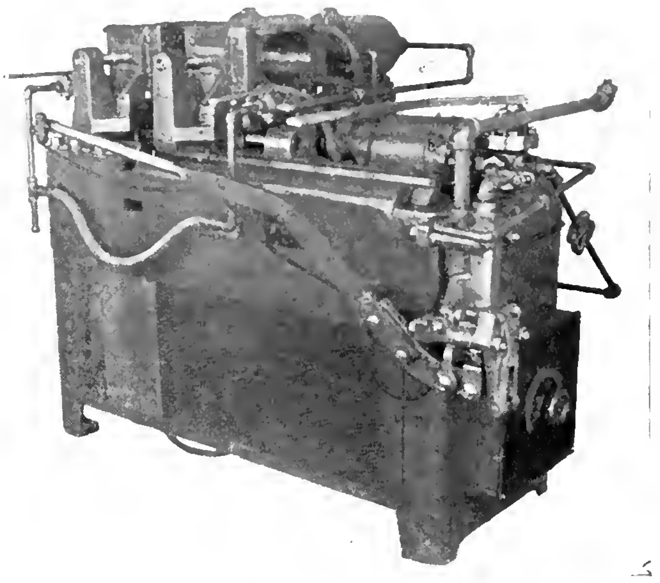
Reversal of direction of platen travel is secured, when using method (1), by throwing a reversing lever through an angle of about 45 degrees; when using method (2), by means of a four-way valve, and in method (3) by means of a control lever or handle on the oil gear pump itself. Method (1) has been most commonly used in the past for it gives the operator complete manual control of the push up of the weld, but the physical effort is somewhat tiring on him. Method (2) has been used to a lesser extent, but is favored by some because it relieves the operator from any exertion in pushing up the welds or in withdrawing the platen.

Method (3) is a new development within the last year and due to its ease of operation and fine control gives great promise of a wide use in future. This latter method is now used by the Illinois Central Railroad at McComb, Miss.

The voltage and current regulation for various sizes of flues is obtained by means of a special five-point regulator switch mounted on the right hand end of the welder frame. By turning an insulated knob, the current can instantly be changed to suit the particular weld being made. All copper dies are thoroughly watercooled as is also the secondary lead connections, thus insuring cool operation of the outfit at all times. The transformer is of improved design with series primary windings and multiple secondary leads, covered by U. S. Patent No. 1375765 giving the highest efficiency ever attained in a welding transformer.

The dependability of the electrically welded flue and its economy over the force process has been vouched for by many prominent railway officials, among whom are Mr. W. H. Lewis, superintendent of motive power, Norfolk & Western Railway Company; Mr. J. J. Sullivan, superintendent of machinery, Chattanooga, St. Louis & Nashville Railroad; Mr. George B. Halstead, shop superintendent of the Virginian Railway Company, and many others.

The great western railroad systems are rapidly adopting the electric flue welding process and officials of the greatest systems of the East have the matter under advisement at the present time. A Thomson flue welder was recently installed and is now operating steadily in the Lehigh Valley Shops at Sayre, Pa.



Type 60 S. P. Welding Machine for Safe-Ending Boiler Tubes

TABLE 1 PERFORMANCE OF ELECTRIC WELDER

Size of Flue	Time in seconds (welding only)	Production in 10 Hours Welded and Rolled	Cost per 1,000 Welds at 1c per K. W. H.
2"	About 12	700	$1.25
3"	" 14	500	1.75
4"	" 20	250	3.00
5 3/8"	" 30	75	5.00

The Industrial Importance of Conserving Eyesight

(*Continued from page* 161)

The plan, which follows revelations of human and industrial waste in industry, made by the Hoover Committee on the Elimination of Waste in Industry of the Federated American Engineering Societies, of which J. Parke Channing of New York is chairman, aims to determine the extent to which attention is being given to the conservation of vision in the educational, commercial and industrial activities of the United States. A study of statutory provisions now in force and affecting eyesight will be carried on.

Experiments to determine the true economic value of perfect vision will be made. It is proposed to measure the improvement in health, increase in quality and quantity of production, advancement of individual performance, and decrease in losses due to waste and accident.

Members and Guests of The Master Boiler

Master Boiler Makers Hold Annual Convention

Great Interest Shown in Committee Reports and Discussions and in Future Plans of Association

THIS year the Master Boiler Makers' Association held its fourteenth annual convention at the Hotel Tuller, Detroit, Mich., May 22-25. Although the attendance was slightly less than that of last year at Chicago, there were almost six hundred members, guests, supply men and members of the Ladies' Auxiliary present. Almost two hundred and fifty members of the association registered and practically all of these kept in close attendance at every session of the convention up to the closing meeting. The interest in all proceedings of the association throughout the entire week was keen.

The convention came to order at 10:15 A. M. Tuesday, May 22, with President Thomas Lewis in the chair. After the opening invocation J. C. McCabe, general boiler inspector of the state of Michigan, acting for the mayor of Detroit, welcomed the association to the city. In part his address was as follows:

For the past fifteen years I have been actively engaged in boiler matters, as the state inspector of boilers for the state of Michigan, and also in the city of Detroit. While the inspection of boilers, in Detroit, has been conducted for the past forty-two years, my connection dates back to 1908, at which time I entered the office and found that there was really no standard for boilers.

I looked about and found that the state of Massachusetts had, a year or two prior, adopted a high standard for boiler construction, and so later, June first, 1910, it was adopted as a law for the city of Detroit. In 1917 a bill was passed, which was adopted by the state legislature, which provided for the use of the A.S.M.E. boiler code for all boilers constructed in Michigan. It happens that I am a member of the Board, and Chief Inspector of Boilers for the state of Michigan.

I have always had much admiration for the high technique of design and the materials used in locomotive boilers, particularly on some of the principal roads of the country. Of course, as in stationary practice, you find some obsolete boilers in use.

There is no question but that locomotive boilers are well cared for and we have very few accidents. In fact, if an explosion or a failure occurs in a locomotive boiler in the use of a railroad, the users and the owners are much surprised.

The best possible materials are used, but at the same time it is unreasonable to expect that a boiler of such high pressure as locomotive boilers will not have a small percent of failures. They are to be expected, a very few of them.

President Lewis' address to the association followed:

President's Address

The past year has been a year of constant strain. Never before have master boiler makers been in such demand by their employers, and from the outlook the future holds no relief. It has been said that the boiler on a locomotive must be maintained to not less than 99 percent efficiency, in order that the locomotive of the present day can be used to its full capacity. An inefficient boiler means an inefficient locomotive. Someone said some time ago that the boiler on a locomotive is not less than 97 percent of the efficiency of the entire locomotive. That being the case, then we as master boiler makers, and all foreman boiler makers, and all boiler inspectors must educate ourselves to the highest degree in our life's work to meet the demands that are placed upon us.

The foreman boiler maker of today, as a practical man, cannot be ignored. The emergency of the present day will not permit it, and it has been very strongly demonstrated during the past year. The boiler foremen on the railways of the United States during the year that has just passed, have done a work for their employers which can never be repaid in dollars and cents. And, judging by the outlook in the future, the master boiler makers' responsibilities have no limit.

The remainder of the opening session was taken up with the secretary's and the treasurer's reports. Membership at present is about 400 with almost 200 members delinquent in dues in addition. Questions on finance that were brought before the convention were referred to a later session of the convention for discussion.

Makers' Association at the Convention in Detroit

Secretary H. D. Vought brought up one other matter at this time. At the convention last year Dr. Koyl, engineer of water service of the Chicago, Milwaukee and St. Paul railroad, requested that a committee be appointed to investigate the experience of the members in the matter of corrosion and pitting of locomotive boilers. This committee compiled complete data on the subject taken from the records of practically all the more important roads in the country and submitted the report to Dr. Koyl. The subject is of great interest to the members of the association and the secretary advised the convention that a copy of the report is on file in the secretary's office.

(This report will be published in an early issue of THE BOILER MAKER.)

A. G. Pack, chief inspector, Bureau of Locomotive Inspection sent his regrets to the association because of his inability to attend the convention this year. An abstract of his communication to the secretary follows:

ABSTRACT OF A. G. PACK LETTER TO THE ASSOCIATION

"It is with deep regret that I now find it impossible for me to attend the fourteenth annual convention of the Master Boiler Makers' Association and share with it the pleasure and profit which I feel sure will result from the exchange of ideas and the greetings of many friends and the new acquaintances which such conventions bring.

"I trust that the results of their labors will be handed down to future generations as a guide post in improved methods of construction and repair of one of the most important parts of the machinery which at the present time goes to make up great transportation systems of the world. Without the locomotive boiler strongly constructed and kept in good repair, the great arteries of transportation would become greatly congested, if not completely blocked.

"I believe that the railroads of this country can make no better expenditure of money than that of not only allowing, but compelling their master boiler makers to assemble annually for the purpose of exchanging ideas regarding their profession.

"Under our present system of transportation the steam locomotive is the most important factor in its successful operation and without a boiler properly constructed and maintained the locomotive becomes a menace to the great army of railroad employees and travelers thereon. On the other hand, when in good condition it becomes one of the most useful instrumentalities."

Wednesday Morning

The meeting convened at 9:15 A. M. with President Thomas Lewis in the chair. At the opening of the Wednesday session applications of 30 new members were ratified unanimously by the convention.

Because of the absence of A. G. Pack, chief inspector, Bureau of Locomotive Inspection, J. A. Shirley representing him read a paper on boiler failures. An abstract of this paper will appear in the July issue.

The subjects scheduled for discussion at this session of the convention were then introduced.

Hammer Testing Staybolts

THIS report embodies the substance of individual reports by the other committeemen as well as information gathered by the chairman from various railroads through the country.

In making hammer tests, size and weight should be left entirely with the inspector. Every inspector and boilermaker has a hobby of his own and wants a hammer just a little different from the other fellow's. For this reason, it should be left somewhat to the inspector, as it is his touch or sound that detects broken staybolts, and not the size or weight of testing hammer.

As to whether staybolts should be hammer tested or under hydrostatic pressure, the Laws, Rules, and Instructions for Inspection and Testing of Locomotive Boilers, promulgated by the Interstate Commerce Commission, must be complied with first.

We believe it practical to hammer test staybolts while the boiler is under hydrostatic or air pressure. However, this cannot be successfully done on monthly inspection in roundhouse, or when engine is undergoing classified repairs. We believe, and recommend that staybolts should be hammer tested while boiler is empty. In the roundhouse, we believe this should be done just as soon as the boiler is emptied of the hot water and while the firebox is somewhat expanded. In back shop, when engine is undergoing classified repairs, the staybolts should be hammer tested and inspected from interior of boiler, and all defective bolts renewed. When repairs to boiler are completed and hydrostatic pressure applied, all staybolts should be hammer tested again while boiler is under pressure.

Report prepared by a committee consisting of J. A. Holder, chairman; C. F. Petzinger and William G. Bower.

DISCUSSION

Charles P. Patrick, Meadville Machinery Company: I want to say that the committee's report on hammer testing of staybolts is common sense and logical. Each man has his hobby, in regard to hammer testing. He has his sense of touch and he should use it, but I rise to make a motion that this association, since we have had so many broken bolts in combustion chamber engines, those equipped with flexible bolts, particularly, that we go on record that we hammer test flexible staybolts each time we test the other staybolts.

W. J. Murphy, Pennsylvania System: Mr. President, I think that is the rule now on all railroads, that you test all staybolts when you go into the firebox, hitting all the bolts in the firebox.

H. J. Wandberg, Chicago, Milwaukee and St. Paul: On our railroad, we hammer test all staybolts, whether flexible or not, but we have the end of our flexible staybolts marked with red so that we can distinguish them from the rigid staybolts. I think most railroads are carrying out that practice of testing all staybolts.

A. W. Schelton: On the Frisco System we have no flexible staybolts marked and every bolt is hammer tested once a month—all of them. We are of the opinion that we find almost as many flexible staybolts broken as we do rigid staybolts in our monthly tests. We find those broken bolts by going over them with at least one hundred pounds of steam, and then we cool the engine and go over the rest of the bolts.

Charles P. Patrick, Meadville Machinery Company: I want to make an explanation of my motion. Some railroads make tests on flexible bolts, but the law requires you to test those bolts only once a year under pressure, and so all are not tested. Now, in the company with which I am associated, we test our bolts every month. If an inspector knows that a combustion chamber is equipped with flexible staybolts and that he is not required to test them, he is liable not to do so each month, since the law requires taking off the caps every twenty-four months. We find broken flexible bolts under the hammer test. We find them broken every month. It is only a short time ago that we found four in one engine and four in another under the hammer test. Even if you do not do so usually, if you suspect the bolt is broken, from the hammer test, it will pay you to remove the cap.

L. E. Hart, Atlantic Coast Lines: We have a class of engines equipped with flexible staybolts in the combustion chamber, and we hammer test them and find lots of them broken. We hammer test all of the bolts, and whenever we have the expansion stays in front, we find some of them broken.

A. N. Lucas, Oxweld Railroad Service: Is it not a fact that the federal boiler law and rules requires us to test all bolts every month? According to the rule, the cap shall be removed every twenty-four months, but does it not say we should test the bolts every month?

E. W. Young, Chicago, Milwaukee and St. Paul: Rule Number Sixteen states: "Method of testing flexible staybolts having caps. All flexible staybolts having caps over the outer ends shall have the caps removed at least once every two years and also whenever the United States inspector or the railroad company's inspector considers the removal desirable in order to thoroughly inspect the staybolts. The firebox sheets should be examined carefully at least once a month to detect any bulging or indications of broken staybolts. Each time a hydrostatic test is applied, the hammer test required by rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure and proper notation of such test made on Form Number Three."

In order to overcome any mistakes we instruct our men, where it says, "Firebox sheets should be examined carefully at least once a month to detect any bulging or indications of broken staybolts," to examine flexible as well as rigid staybolts, and they cannot examine sheets without testing each and every staybolt. They will detect bulging or any other flaws when they examine the sheets carefully, and we instruct them to test all staybolts.

Charles P. Patrick: It is not in the rule to hammer test staybolts.

E. W. Young: No, but to overcome the trouble in the sheet, we must examine the bolts, and there you have the rule.

Thomas Lewis, Retiring President

E. W. Young, President

Frank Gray, First Vice-President

W. J. Murphy, Pennsylvania System: I have had some little experience in testing staybolts and here is what we have found in testing flexible staybolts. We have a medium sized hammer for testing the ordinary staybolts and about twice the size for testing flexible bolts. We have found that by using a larger hammer we get better results. The question came up as to whether you find flexible bolts broken or not, and I will tell you that you can find them by hammer testing them. Any good inspector will find broken flexible staybolts, but he will get better results with a larger hammer.

R. C. Young, Chicago and North Western: I would like to know if a flexible staybolt, when the boiler is not under pressure, is not in the same condition as other broken staybolts? It is loose, not bent nor separated, and there is not much success from testing flexible staybolts unless you have pressure on the boiler and tension on the bolts, because when there is no pressure in the boiler, it seems to me much the same as when a bolt is broken.

T. W. Lowe, Canadian Pacific: We find in the law, as agreed, that there is nothing in it which tells us that we cannot do something better than what the law suggests. Therefore, on the western line of the Canadian Pacific, where we use the flexible staybolts, in general, we find it very advisable to have water pressure to the extent of 140 pounds at every test, every thirty days' test—shop test or

A Few of the Convention "Notables"

1. The new president and his smile. [illegible] "Lew" Stewart. 3. W. J. Murphy. [illegible] Dr. [illegible] Paton [illegible] F. J. Reardon [illegible] Major Lester. 7. A. S. Greene and John Campbell. [illegible] "Abe" Lucas, the M. B. M. movie star [illegible] "Andy." 10. "Dan" the other Lucas twin. 11. J. O. Crites of the "Ancient and Honorables." 12. P. J. Conrath. [illegible] the latest addition to the "Past Presidents." 15. "Ed" Rogers. 16. "Charlie" Patrick. 17. J. F. Raps. 18. [illegible] W. H. [illegible] "The watch dog of the treasury." 20. "Uncle" George Riley. 21. "Harry" the "Pooh Bah" secretary. 22. H. J. W[illegible] [illegible] of the Crowd. [illegible] "Jim" Kel[illegible] 25 and 26. Just a few of the High Lights.

any other kind of test. This is done for the very reason, that you will not find broken flexible bolts otherwise. We have found, from our experience, in applying a test with 140 pound pressure, that you find a greater number of broken staybolts than you ever expected to find.

Mr. Wallough (Omaha): I believe in this discussion, here today, you will find that the hammer testing of staybolts is very nearly a lost art. We do not have the old-timers on the job that we used to have and you find very few inspectors get on the job and find the flexible, or any other kind of staybolts, that are broken with the hammer test. When a man follows them up, he finds some more. I have done that, myself. I think when it comes down to broken staybolts, flexible staybolts in particular, that we ought to get together and find some other method so that we can determine whether they are broken or not. I understand there is such a move on, now.

H. V. Stevens, Atchison, Topeka and Santa Fe: I would like to ask the convention if they want to go on record to remove the brick furnaces on oil burning engines? There are screw bolts and there are detector holes throughout the bolt, and does this include the matter of hammer testing them every thirty days?

time we have had a few broken staybolts; and everything that can happen in a combustion chamber, can happen anywhere else, where a combustion chamber boiler is in use. I would like to know what others are doing to get away from this trouble, because I cannot do it. The broken staybolts, both flexible and rigid in the combustion chamber engines cause trouble. I know it is due to the construction of the crown sheet being almost flat with the radial stayed wagon top. If there are any Pennsylvania men here, who have had experience with combustion chamber engines in this connection, I would like to hear them tell us about it. I imagine with Belpaire boilers they are not having the trouble as with the radial stayed boilers.

H. J. Wandberg, Chicago, Milwaukee and St. Paul: We have a number of combustion chamber boilers but we have none that Mr. Raps refers to, that is Belpaire boilers. As far as maintaining combustion chamber boilers, I find they are no particular trouble, with the exception of the short combustion chamber boilers. We have a number of broken bolts at the bottom, but as far as any other part of the boiler is concerned, or the firebox, we have no bad results at all. We get best results with 36-inch combustion chamber.

L. M. Stewart, Atlantic Coast Lines: We have a lot of trouble with combustion chamber engines, with inside flue sheets cracking. We did not have fire cracking from the rivet, but we certainly do have trouble with cracked knuckles inside the flue sheet. Not only that, but we have a great deal of trouble with broken staybolts in the combustion chamber, regardless of whether they are flexible or rigid type.

T. F. Powers, Second Vice-President

J. F. Raps, Third Vice-President

W. J. Murphy, Fourth Vice-President

T. F. Powers, Chicago and North Western: I think that is specifically covered in a rule handed down by the Department of Locomotive Inspection. As I remember it, it says when bolts are applied back of the brickwork, having a hole all the way through, they do not have to be hammer tested.

H. V. Stevens: Was not the motion that all screw bolts be hammer tested?

Chairman Lewis: I think this gentleman is justified in this question. Mr. Patrick includes every staybolt in the firebox, and I think that is well taken. We have a number of those bolts, as you suggest, Mr. Stevens, and if we had to hammer test them all, we would have to take out the grates. I think we should change the motion.

Charles P. Patrick: I will change my motion, Mr. President, and make it that we treat all flexible bolts just as we treat rigid bolts.

A rising vote on this motion resulted in its passage.

Are the New Combustion Chamber Boilers as Easy to Maintain as the Straight Firebox?

This report was prepared by a committee consisting of H. J. Raps, chairman; Emil Ziegenbein and F. J. Howe, and will appear in full in the July issue of THE BOILER MAKER.

DISCUSSION

John F. Raps, Illinois Central: We have some government standard locomotives received two years ago and since that

John Harthill, New York Central: We have combustion chamber engines on our road. With our large engines we have twenty foot flues and combustion chamber of forty-two inches, and we have more trouble with that class of engines than any others that I know. Our trouble is in the flue sheet, cracked arch tubes, broken staybolts, and so on. In our large Mallets, when they came in for inspection, they always had from thirty to forty rigid bolts broken, even when we had made careful inspection and installation of them. Now, we find flexible bolts broken on the right and left side, the first seven in the flue sheet and fourteenth to eighteenth row from the bottom. That is where we find the broken flexible bolts—that is, on the large combustion chamber engines. On the smaller ones, with shorter flues, we find broken staybolts on the bottom of the chamber. Our flues crack top and bottom on these combustion chamber engines and it seems the flue sheets are leaking continually.

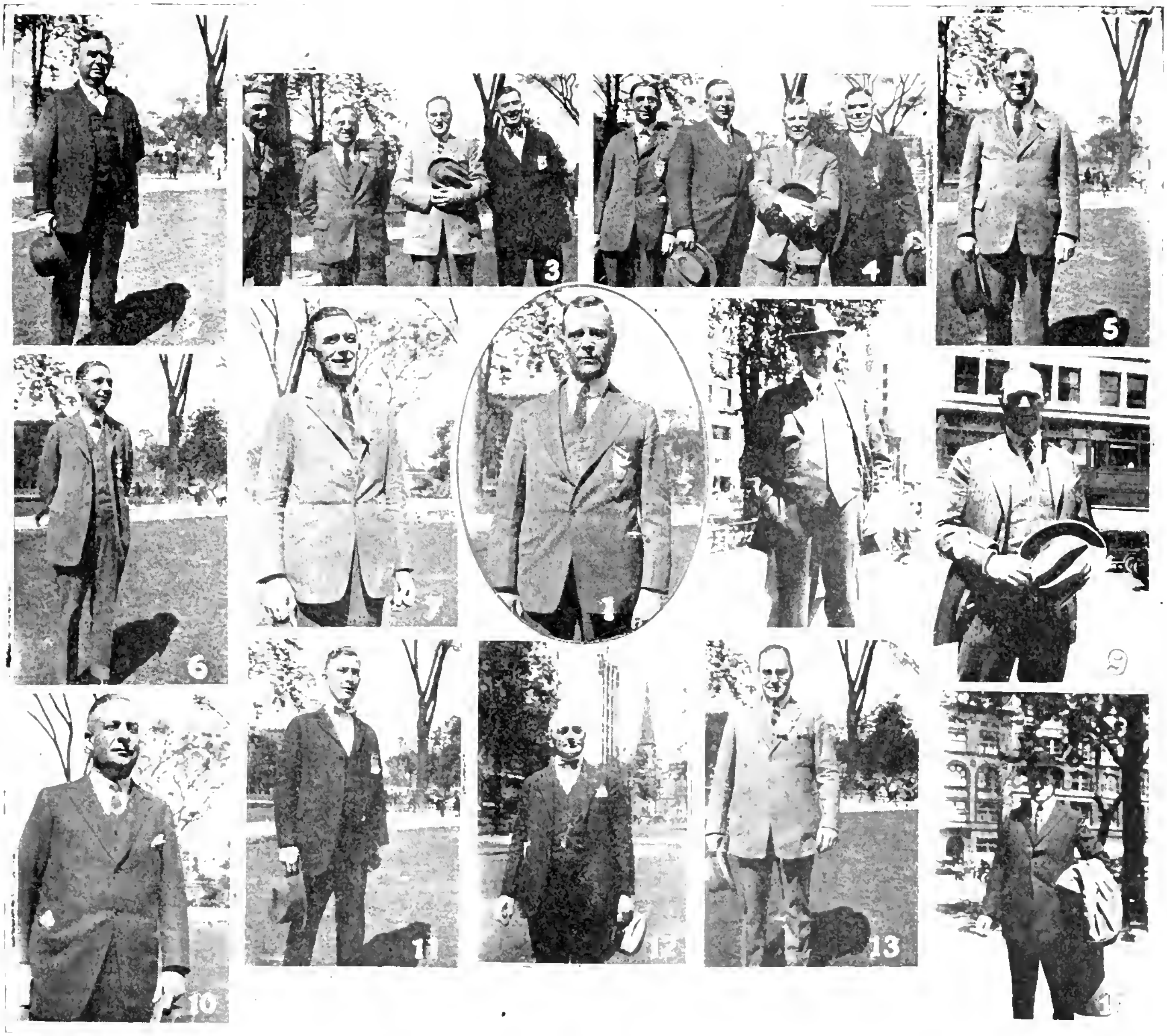
W. H. Laughridge, Hocking Valley: We have the combustion chamber engines and we have them from twenty-four inches to seventy-two inches. The majority are seventy-two with twenty-four foot flues. We have quite a number of engines that the sheets are welded in and we have no trouble at all with them. The seam in the combustion chamber is at the bottom and if it is welded, you never have any trouble. We have found a few broken bolts in the first row, next to the flue sheet, when in service three years; some of them five. We renew the flue sheets every few years.

So far as the maintenance is concerned, after you get the sheets welded in, I do not think they are any harder to maintain than a straight sheet. I do not think it would be practical, with a class of engines that we have, to increase your flues six feet, but you have to have a boiler to suit that engine and the only remedy, then, is your combustion chamber and the advantage of the combustion chamber is your increased crown sheet heating surface. So far as trouble with broken staybolts is concerned, we have had very little of it.

T. W. Lowe: I would like to state a few words, in connection with this subject, along the lines of design. Shortly before leaving Winnipeg, I had the opportunity of seeing a blueprint which, at first sight, I took very grave objection to, but after some thought I began to lean toward the suggested design shown on this print. This refers to the belly stays, which according to the design of combustion chamber engines which you have in universal use in the United States and in Canada, those belly stays are secured from the flue sheet to the shell of the boiler, whereas on this suggested print, that I saw, these belly stays are secured to the shell of the combustion chamber. It strikes me, forcibly, gentlemen, that that is the proper place for them. You want your flue sheet to move with your combustion chamber and if it does not move with your combustion chamber, it is not a free working portion of the boiler, as it should be. It is liable to all the defects, which we find in that lower combustion chamber.

Now, just how you would secure them, is uncertain as yet, but I believe by placing them around the bottom of the shell of that combustion chamber, that you leave a more free passage for the bottom shell of the boiler in the firebox.

A. N. Lucas: I was with the Milwaukee Railroad for years and I believe this subject has been thrashed out previously on the floor of this convention, especially in regard to the braces from the bottom of the shell to the inside



Officers and Others of the Supply Association Who Helped Make the Convention a Success

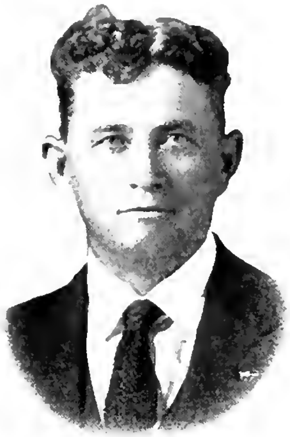
1. George R. Boyce, new president of the "Supply Men". 2. S. F. Sulliv[illegible] Just a few of the members. 4. Some of the officers. 5. John Kuhns. 6. W. H. Dangel. 7. Fred McCabe. 8. John Campbell. 9. Ralph Ben[illegible] Bill Wilson. 11. An "Active" member. 12. "Doc" Bateman. 13. C. C. Rosser. 14. Frank O'Brien.

flue sheet. I had it up with our people at the time, that the braces in the combustion chamber boiler, such as we had, were of no benefit and should not be there. There is a tension strain different from the expansion of the shell and firebox, and after I left the service of the Milwaukee Road, the mechanical engineer, and others, gave orders that these braces be removed. I found that in applying the combustion chamber boilers, that there was a difference in the roll of the inside flue sheet. On our combustion boilers we found a very large roll on the flue, a good radius, and for that reason we did not need those braces. In looking over the design for many other railroads, we found they had a flat surface, there, and called for braces, but with our design it was not necessary, and so the majority of the combustion chamber boilers on the Milwaukee Railroad were running without braces. I notice in getting around the country, as I do, that they do have trouble with broken bolts, leaky seams and keeping up short combustion chamber, but the best results are obtained from thirty-seven-inch combustion chamber. Furthermore, many of these railroads do not watch them properly. They watch the bottom of the shell, but do not know whether there is congestion of mud between the combustion chamber and the shell, and that is the trouble many times, I believe. I think they should be washed from the front end, and a thorough inspection made to see that it is kept clean. I believe we should have at least six inches of water space down there so if they are getting less, you can tell it, and that will overcome some of the breaking of your staybolts.

E. W. Young: I am very much surprised to hear that they have been having so much trouble with combustion chamber engines, because we feel the advantage of the combustion chamber engine is much greater than the disadvantage. We eliminated the belly braces also, and where the flue sheet was cracking, we put in flexible bolts around the bottom, and also increased the thickness of the flue sheet and we have gotten away from nearly all of that trouble. They are giving us so much better service than any other engines that we do not want to do without them. We have had some in service for over twelve years and never had a firebox removed.

Mr. Foley, C. B. & Q.: We have several combustion chamber locomotives on our line, especially lines West. In fact, we have some that have been in service for seven years and we do not have trouble with them. We did have, in regard to our staybolts breaking, when we were using rigid staybolts, but since applying the flexible bolts, we have no trouble. We had a little trouble with cracking in the flue sheet in the combustion chamber engines, but that was before the arch tube was applied. The cracking of the flues comes at the bottom, one on each side, and we have no trouble otherwise, except the pitting of crown sheet over the top of the combustion chamber. We feel we have had good success with the combustion chamber engines.

C. A. Seley, American Flexible Bolt Company: As a designer, I would like to put in a plea for consideration of the combustion chamber. If you are going to make boilers just for the boiler makers, then your straight sheet would be the thing, but you are making them for the engine, and it has a wheel arrangement and that calls for a certain length of boiler. If you can save that length of flue in the combustion chamber, which has a value six to one, practically, in evaporative effect to each foot of flue surface that runs over eighteen feet, I think the point is worth consideration. In regard to breaking staybolts, and every other staybolt in the boiler has practically one flat surface on which to relieve a certain amount of staybolt stress, the combustion chamber is tying two circular sheets together and that construction makes it just as rigid as your outside sheet, however thick it may be. Consequently the lateral movement, and fore and aft movement of the chamber in relation to the shell, sets up an angular movement on those bolts. Now those bolts get as much movement as those below, but they are long and can absorb movement, and then, it is a much less degree of angular movement, though it measures the same in extent that you get below, being six inches or less.



L. M. Stewart, Fifth Vice-President

W. H. Laughridge, Treasurer

H. D. Vought, Secretary

E. J. Reardon, Chairman, Executive Committee

Wednesday Afternoon

The afternoon session opened at 2 P. M. with President Lewis in the chair.

Frank McManamy of the Interstate Commerce Commission, who was to have addressed the convention, sent his regrets as official duties in Washington prevented his attending the meetings.

Inspection of Boiler and Firebox Plates

In the opinion of the committee the subject is one which should be handled by the American Society for Testing Materials. However, the suggestion offered relative to rejected plates is a good one and we submit the report with the recommendation that after it has been discussed and passed upon in convention, it be turned over to the American Society for Testing Materials and that they pass upon it.

All boiler and firebox plates must be of shape and size ordered, sound and free from cracks, surface flaws and laminations. The thickness of each plate shall not vary under the gage specified, more than 0.01 inch. Any plate showing injurious defects such as seams, pits, scale laminations, cracks at the sheared edges, or other serious defects, or which develop defects in working, will be rejected. No hammer dressing, patching, burning or autogenous welding to correct rejected plates shall be allowed.

Boiler plates showing indentations of five percent of thickness and firebox plates showing indentation of three percent of thickness will be rejected. No autogenous welding shall be allowed to rebuild these to the required thickness.

This report was prepared by a committee consisting of Charles P. Patrick, chairman; C. H. Browning and John J. Orr.

What Are the Best Methods of Detecting Defective Boiler Sheets in the Shop Before Going to the Laying-Out Bench and Put Into Service?

OUR method of inspection of firebox steel in our shops before going to the layout bench is as follows:

Surface Inspection: In making the surface inspection, a close examination is made of both sides of the plates and all edges, and the plates are rejected when the following defects are found to be present:

Blister	Dished	Crop ends
Pitted	Piped	Knifed
Slivers	Scored	Snakes
Seams	Imbedded scale	If any grinding has been done
Burnt	Cambered	
Bricked	Laminated	Cracked
Scabby	Roll marked	Wrong dimensions
Cinder spots	Bad edges, caused by shearing	Wrong gage
Split		Not bearing proper stamping required, i. e., heat numbers, serial numbers, manufacturer's name or initial

Material inspectors in inspecting firebox and boiler sheets follow the following procedure, making their tests as listed:

Bend Test: In the case of boiler steel, a test specimen for bend test is cut traverse to the length of the sheet as rolled, at the top of the sheet. This test specimen is then bent cold 180 degrees, for material one inch and under, around a mandrel having the same diameter as the thickness of the specimen, and for material one inch and over, around a mandrel having a diameter twice the thickness of the specimen.

In the case of firebox steel, a bend test specimen is cut from each sheet as ordered. The sheet as rolled is cut into the dimensions of the individual firebox sheets ordered, this test specimen being cut longitudinally. Before and after quenching, it must bend cold 180 degrees flat without fracture at the bent portion. The quenching is done at a bright cherry red, in water at 80 degrees to 90 degrees. In the case of firebox steel, in addition to the bends before and after quenching, a nick bend is made on each firebox sheet from one end of the tensile specimen, and this nick bend test must not show laminations exceeding ¼ inch in length, seams, cavities of foreign interposed matter, such as cinder, slag, etc.

Tensile Test, Boiler Steel: One test piece cut longitudinally from each sheet as rolled is pulled in the testing machine and the following determined:

Tensile Strength
Yield Point
Elongation in 8 inches

In making the tensile tests, a check on the gage of the material is made, and also the fracture and edges examined for any defects, such as laminations, etc. To determine that all plates are represented by the test piece, where more than one plate is sheared from a single slab or ingot, each plate is match-marked so that all plates sheared from a single slab or ingot can be identified with the test pieces identifying them.

Firebox Steel: A tensile test specimen cut longitudinally from each sheet as ordered is pulled and the following determined from the test:

Tensile Strength
Yield Point
Reduction of Area
Elongation in 8 inches

In making the tensile tests, a check on the gage of the material is made, and also the fracture and edges examined for any defects, such as laminations, etc.

Chemical Analysis: Drillings are taken from the tensile specimens and submitted to the laboratory for chemical analysis to determine the following:

Carbon
Manganese
Phosphorus
Sulphur
Copper, when specified

Gage: All the plates are checked for gage and our specification states that the thickness of the plates shall not vary more than .01 inch under that ordered, the full dimension being controlled by the weights as specified.

Weight: The plates are weighed and all plates having the same width and thickness must conform to the permissible variation in weights as outlined in specification.

This paper was prepared by a committee consisting of John J. Keogh, chairman; John P. Powers and J. C. Keefe.

Discussion

J. F. Raps, Illinois Central: When a plate is on the bench, there may be a gas pocket found that will not be apparent unless they shear through it. We often place a sheet over the forge and heat it in order to expand the gas to determine whether or not a gas pocket is in it. That, I believe, was the intention of this paper and not go into the inspection in the mill, but the inspection and testing of the plate after it is turned over to the shop.

J. A. Anderson, Industrial Works: The only system we use, in inspecting boiler plates when they come to the laying out bench, is to give them a thorough inspection with the eye, on both sides, to see that there are no visible defects. If there is any suggestion that there might be something wrong, we put the plate under a magnifying glass and that will detect any small flaw. The plate is laid out and rolled and after it is rolled, that is the time to find the defects. After it is rolled, we find, sometimes, a small piece will roll out, showing that scale was present. Sometimes we find laminations after rolling. We scarcely ever find any defects before the plate is punched and rolled.

President Lewis: We have found occasionally that after sheets have arrived at the plant, notwithstanding the tests made at the mills, where the sheets have been defective, laminations and blisters in the inspection in the shop, and often by the man who is laying out the work.

John F. Raps: A great many times, in shearing a plate, we run into laminations or we find defects by rolling the plate. Sometimes we find a gas pocket. Again we have put in the sheets and found when they were in service a few weeks, that there was bulging on the sides of the sheet, and then it cracks an eighth of an inch, and there would be a gas pocket or lamination. You may find it necessary to chip it off with the hammer in order to show it up. Now, the intention of these topics is to find out if any member, here, is following out any system of inspection of these plates or doing anything before applying them to the boiler, to determine whether there are laminations or gaspockets in them.

We all give them visual inspection on the layout bench, but sometimes these things happen after they have been applied. If any one is following out some other system than has been mentioned, such as putting plates over fire and heating them in order to bring out the gas blisters, or any other method of inspection, let us hear about it.

Edward Hunt, Illinois Central: In making center punch marks on the layout bench you will often run into a blister. Sound the plate with a hammer to see the surface defects. Watch the laminations around the edge of plate and take a general view of it. Follow up the plate when it is sheared. Sometimes, you find laminations away from the original edge, after you have cut through it. Close observation is important, watching your surface and the thickness. Sometimes by cutting you can see defects.

The Use of Automatic Stokers in Locomotives

THIS report was prepared by a committee consisting of H. A. Bell, chairman; C. A. Nicholson, and C. J. Baumann. The complete report will appear in the July issue of the magazine.

DISCUSSION

John Harthill, New York Central: We are applying mechanical stokers on our road, now, and we have not had a great deal of experience, but I would like to find out whether members have more leaky staybolts with mechanical stokers than with hand fired locomotives.

T. W. Lowe: We have a stoker fired engine on the Canadian Pacific and we operate in the same district, with the same water, as hand fired engines of the same type and get the same service. These engines are three years old, of the combustion chamber firebox design of fireboxes.

Mr. Kessel, Burlington: We have about one hundred locomotives that have been in operation eight to ten years, with stokers. The side sheets have not been renewed, nor have the fireboxes been renewed in that period of time.

W. H. Laughridge, Hocking Valley: We have been using stokers for ten years and we usually renew the side sheets in three years. We have eleven engines that have been using a stoker for ten years and we are just now renewing the side sheets. On the larger power, we have three different types of stokers, and I see no difference between the stoker fired engine, in regard to staybolt leakage or other firebox leakage. We have considerable staybolt leakage, naturally, because we have very bad water, but if there is any favor at all, it would be in favor of the stoker fired engine.

D. A. Lucas: My experience is that the stoker is a benefit to the firebox when no cold air is admitted. We know that cold air is a detriment to the firebox, when the fire door has to be opened and shut whenever coal is put into it. The stoker is a big benefit. The firebox is bigger, the engine is bigger, and it is pulling more tonnage.

J. F. Shea, Missouri Pacific: We have stoker fired engines on our railroad that have caused us a great deal of trouble. In fact, we renewed the side sheets one year and a half after the engine was built, and there were leaking staybolts then. We have other engines that are two years old that we are not having any trouble with, so it may be a good deal in the steel that is put into the firebox.

H. J. Wandberg, Chicago, Milwaukee and St. Paul: We have a number of stoker-fired engines and we have not experienced the trouble the gentlemen have been speaking about. We do not find any difference, so far as maintaining the firebox or side sheets are concerned.

W. J. Murphy, Pennsylvania System: We have some stoker-fired engines on the Pennsylvania. I believe the stoker-fired engine is preferable. We do not have any more trouble with a stoker-fired engine than we do with a hand-fired engine, and I really do not see any difference between them. We have never had any trouble with the side sheets cracking, as some of you have said, and I move that this discussion be closed.

After the completion of the discussion the subject of association finance was introduced and discussed quite exhaustively at this and later sessions of the convention. As has been the experience of all associations, expenses of maintenance, printing of proceedings and reports, convention expenses and the like have increased far more rapidly than membership and income. In the case of the Master Boiler Makers' Association, the same remedy was necessary as in other associations. After careful consideration the Executive Board recommended to the convention that the annual dues be raised, to go into effect April 1, 1924. The subject was carried through two sessions of the convention and annual dues were finally fixed at $5, while the initiation fee remains the same as before—$3.

Thursday Morning

The meeting convened at 9:15 A. M., President Lewis presiding.

What Is the Standard Method of Applying Flues in Locomotive Boilers?

THIS report which was prepared by a committee, consisting of A. F. Stiglmeier, chairman, E. C. Umlauf and James F. Walsh will appear in full in the July issue of THE BOILER MAKER.

DISCUSSION

D. A. Lucas: In putting in flues, I am not in favor of the narrow shim at all. At one time we used the shim an eighth of an inch wider than the sheet, but when you prosser, the ferrule sticks up and forms a mud pocket between the flue and sheet. In the bad water districts, some time ago, it was impossible to keep the flues tight. We were using a narrow shim and the idea struck me to use the wide shim. We put in a set of flues in the same engine, where we were having trouble with the narrow shims, with ferrules wide enough so that when you expanded your flues you expanded them into the shims. The copper formed a shoulder right over the prosser shoulder, in the flue. In performance this was ninety percent better than with the narrow shim.

C. E. Elkins, Pennsylvania: I am very much in favor of the wide ferrule myself. One time the mechanical superintendent of machinery, on our road, advocated the use of the flue copper the same width as the thickness of the flue sheet, and we had all kinds of trouble with our flues. So now we use the ferrules one-quarter of an inch wider than the sheet, and we also use very heavy flue material.

R. A. Creger, Missouri Pacific: On new back flue sheets, we drill holes one-sixteenth of an inch smaller than the size of the flue. On copper ferrules, we use number eighteen Birmingham wire gage on the new flue sheets and on the old flue sheets we use number fifteen. We have very little flue trouble and as far as the copper ferrules are concerned, we use thirteen-sixteenths on all sheets.

A. F. Stiglmeier, Baltimore and Ohio: I would like to ask some members if they have any trouble with the flue cracking, tightening them with the straight sectional expander.

President Lewis: Do you mean, Mr. Stiglmeier, when applying them?

A. F. Stiglmeier, Baltimore and Ohio: No, lots of roads are applying them without using the roller, tightening them with the straight sectional expander. I made a test and found it cracked the flue. I did not detect it until after it was in the boiler for a short time. They seem to crack in the boiler. Lots of them are putting it to the electric welding. I believe the cracking is due to using the sectional expander, when applying the flues. Seventy-five percent of the railroads, from whom we have answers, are applying them with the sectional expander, getting away from the roller expander, and I believe that is what is cracking our flues.

F. L. Biklen, C. B. & Q.: I want to say that the C. B. & Q. has done away with the rolling in the back end since 1904. With copper ferrules we use a standard, now, that is one inch wide and that has been our practice since 1904, and we have found it very satisfactory.

W. Wallough, Omaha: I have used the sectional expander for the last few years and never split the steel flues that I remember. We have split iron flues. You cannot back them out of the sheet and you do not need to roll them when you get through.

C. F. Young, Chicago and North Western: There is one feature about this, where the holes are oblong, after the holes are reamed out, the diameter of the holes increases to the same size as the ferrule. That is, practically, reducing the gage of the flue. I think if the holes are larger in diameter, that the thickness of the ferrules should be increased to maintain the flue to its original gage.

D. A. Lucas: We use copper ferrules a half an inch wider than the flue sheet and the thickness through the water side is another half inch, then when you expand it, you do not crack it. In actual experience, we found with the wide copper ferrule you eliminate what we call "simmer" and at no time do you have a flue spurt, as you will with the narrow shim. When cold air hits it, with the narrow ferrule, it cracks and you have flue leakage, and with the wide copper ferrule, when cold air hits it, it contracts, shortens it and pulls it up to the joint made by the prosser expander and eliminates the simmer and helps your flue in several ways. By actual experience, I have found we decrease the failures and increase the mileage on our flues in many cases (without exaggerating), over sixty percent.

T. W. Lowe, Canadian Pacific: Our practice, on the Canadian Pacific, is that our coppers are cut the width of the tube sheets, and they are pushed into the sheets one-sixteenth short of the fire side of the sheet, allowing them to project one-sixteenth into the water. The purpose of allowing them to stand into the water, is that when we are driving in our flues, it prevents the copper from moving toward the fire. Therefore, when our tube is set, we are positive that the ferrule, which is hidden from view after setting, is not going to be exposed to the action of the gases and create a deterioration around your tube sheet hole. I notice, in the paper, that there is no reference made to the angularity of the rollers, as set in the body of the tube expander. This is one of the most important features of application, and furthermore, it is more important still when it comes to maintenance. This is true for the very reason that if you use a roller expander, set with a different angle, for maintenance, after you have applied your flues you are certainly going to shorten the life of your tube because the metal has been rolled from a certain position in the sheet and you oppose that and crumble the metal, and it is certainly very disastrous to the tube. In putting in flues, it is an advantage to roll them first. That is shop practice, but when we come to the roundhouse, one of our men, who had been studying application and maintenance, to overcome the difficulties that we were encountering, in the roundhouse, conceived the idea that he could get up a tool that would perform dual duties. These duties were that he could stretch the tube in the same operation as the beading of the tube, and he developed a tool which we have in use, today, in our roundhouses, performing these two functions.

H. J. Wandberg: Our practice on the Chicago, Milwaukee and St. Paul is that we clean holes, ream them or fill them as the case may be, and get them as near one size as possible, and apply our copper shims. The flue is cleaned off, the scale is taken off and it is made a driving fit and is driven in through the sheet, the proper length, and then turned over. We do not use any expander except the expander that we finish the flue with. We do not roll our flues in the firebox end. The roller is used for the front end, but not for the firebox end. We test all of our flues first. The reason for doing this is not to depend on the beading tool to make a flue tight. The expander must do that work. We have found, through experience, that lots of tubes are only half expanded, and then the beading tool made them tight, but it failed to do a good job. We have found that testing the boiler, before allowing the flue to be beaded, works out very well. We use a copper ferrule one-sixteenth of an inch wider than the thickness of our sheets. We have two thicknesses, ½ inch and ⅝ inch.

J. A. Anderson, Industrial Works: Fifty years ago I went into a boiler shop. That was before we, in that place, had ever seen a roller expander. The tubes were iron. The ordinary prosser expander has not been improved upon to any great extent, however, in that time. At that time, we had no trouble with flues, when we used the prosser expander. They were expanded with the prosser and beader. However, coming up to recent time, we made an experiment, recently, in the shop, by testing out the boiler before the flues were beaded. We had a special order from a railroad, who required that the flues should be welded at both ends. This was a boiler of sixty-five inches in diameter, and so they were applied, as the rule states here, by having the hole through, the edges sheared, and the copper ferrule a quarter of an inch wider and one-sixteenth of an inch back from the face of the sheet, and fastened by the expander. Then the flues were rolled and cleared about forty-five degrees, and then sand blasted and tested for beading, and we found scarcely and trouble with any flue, and, if there was, it was then beaded and welded and was a very satisfactory job.

President Lewis: Some men are using copper ferrules one-quarter of an inch wider than the sheet. Others are using copper ferrules one-eighth of an inch wider than the sheet, and one member said he was using copper ferrules almost flush, or a little narrower than the sheet. Now, which is better? We are using copper ferrules one-eighth of an inch wider than the flue sheet. If a quarter of an inch is better and gives better service under conditions where the flue service is so very severe and requires attention almost every trip, or once every month under some conditions, I would like to know about it.

D. A. Lucas: To get the best results, the flue has to be long enough so that it covers your sheet. If your flue is going to give you better service in bad water conditions, it surely is going to give you better service in good water conditions. Now, when our road extended up into the West, and went through the worst water conditions—alkali water—and you would take an engine out of the shops with a set of flues set in copper ⅝ inch wide, at that time, and send the engine up to that division, and from three to five months the engine had to come back to the shops on account of flues. The first set of flues put in with wide copper were made from a copper pipe. We could not buy wide copper at that time. We got a set of copper ferrules and put them in an inch wide, or a little better. There was not a lot of care taken in the cutting of their length. A set of flues were applied to that same engine, wide enough so that the expansion was made right in the copper, and that same engine went back to that division and stayed sixteen months without having the flues removed, or having any flue trouble. Now, if those conditions are better served with a wider flue, that ought to be enough to induce a man to use them, and to believe that there is something in the wide shim.

Charles P. Patrick: How do you swage your flues?

D. A. Lucas: They are swaged with gradual taper and all swaged when you use wide shim, and swaged far enough back so that you have a gradual taper and then they stick tight—not an abrupt taper.

Charles P. Patrick: I want to know what kind of swage you use, the gradual?

D. A. Lucas: Gradual, yes, and turned two or three times to get it perfectly round, and, when you swage with that, it thickens the flue and maintains the full thickness of the flue, or a little better, all over. Our method was to prepare the flue sheets, clean out holes and in all cases see that there was a bevel on both sides of the flue sheet, to do away with the sharp edges. Then the flue sheet was applied, and rolled in lightly. Then the flue was driven in and then prossered with the sectional expander that had a taper on the outside that set the bead back to 30 degrees, ready for calking. It did away with that practice of turning the bead over. When you turn the bead over—lots of shops have a turning hammer—you hit the flue right in the neck, where you want the full thickness and, if you put in some flues and cut them, you will find your flue is reduced in the heel of the bead, where you want your strength.

Now, with this method that we use—and I have put in many flues and cut them, and then went into detail to find out the results—when the flue is expanded with this sectional expander, having a flare on the back to throw out flue (no hammer to throw it over), and the proper bead put on, you cut that flue open and you will find out that your bead is thicker right in the heel than in any other part of the flue.

President Lewis: I would like to know those who are using copper one-eighth of an inch wider than the sheet, and those who are using copper one-quarter of an inch wider than the sheet.

Mr. Glenway (Northern Pacific): Our copper extends three-sixteenths of an inch wider than the sheet.

W. H. Laughridge: I would state that we use one-eighth of an inch and get good results.

H. J. Wandberg: I may say that we use one-sixteenth of an inch, and have good results.

Mr. Howe (Burlington): We use one-half inch.

Mr. Mitchell: We use our coppers one-quarter of an inch wider than the sheet and our results are very satisfactory.

P. J. Conrath, National Tube Company: I would like to say that I have used the copper material wider than the flue sheet—one-half inch wider—for twenty-five years. The advantages claimed for the long copper come under two heads. First, you make an easier joint with the prosser on your expander in the shouldering of your flue sheet. Secondly, the closer the copper, if long enough around the back of the flue, the more prevention against sediment getting in between copper and the flue. That is the idea and that is the claim for the longer copper. Now, when your copper is made only one-eighth of an inch longer, it does no good. You simply create a mud pocket because it stands out of your copper only one-sixteenth of an inch and you catch it with the prosser of your expander and almost break the expander to set your flue. That is about all there is to these coppers being longer. Another thing about the setting of flues. I have set quite a few in my time. I have heard no one say where they begin to set flues and where end. That should be taken into consideration. Try to work the flues from the right to the left and you will find you have all the holes oblong. As soon as there is strain, and it gets hot, away goes the hole. Start a set of flues in a diamond in the center of the sheet. That is my method, but it might be a circle. Then work the flues all around so as to allow a place for your expansion in this pocket in the center. The sheet is flexible and will go wherever the expansion will drive it, which is not the case otherwise. If you work the flues all around into this pocket in the center, you keep this undue strain away from the flange.

A. N. Lucas: I believe a sixteenth wider than the sheet is the most satisfactory. We are using a light shim and it is all right. I believe you can use a shim, an expander in putting it in, and have it so that they will set the copper at least a thirty-second inch inside of the sheet, so that when the flue expands it will come out flush with the sheet, and there is no copper between the bead and sheet.

A. F. Stiglmeier: I would like to tell you that the majority of the railroads from whom I have information, are using ferrules 1/8 inch wider than the sheet. We have taken the majority on all points on which we secured information, and placed it into the report.

A. N. Lucas: I believe the flue subject is one of the best subjects that we have. The roundhouse should know how to take care of flues after being put in, in the proper manner, taking care of them in the right way.

P. J. Conrath: If the copper is only one-eighth of an inch wider than the sheet you turn them over, always. Otherwise you are going to have one long and one short, on account of rolling and the different ways of putting them in. The sheet of copper only one-eighth of an inch longer should be turned over against the sheet.

The Life of the Superheater Tube and the Number of Safe Ends That Should Be Applied Before Cutting Down for a Smaller Engine

It is the consensus of opinion of your committee: That great care should be exercised so that as nearly as possible there will be only one weld on each flue. This can be accomplished by applying a five-inch safe end for weld No. 1; 6½-inch for No. 2; 7½-inch for No. 3; and 8½-inch for No. 4, thus cutting off each old weld before applying the new safe end. Welds on the front or large part of the flue are not desirable on account of applying units, etc.

We find it is the practice of some roads to weld on the large end after applying the limit of welds on the small end, while the practice of other roads is to apply only one weld before cutting down for a smaller boiler. This would seem to us a very expensive proposition if the locomotives are equipped with superheater tubes of the same length or nearly so.

We are also of the opinion that a safer weld can be obtained on a superheater tube than on a 2½ and 2¼ tube owing to the difference in the thickness of the metals.

This report was prepared by a committee consisting of J. P. Malley, chairman; H. Howard and Daniel S. Rice.

Discussion

H. Howard, Illinois Central: We will all admit that we cannot determine the life of a flue, definitely, on account of the water. If we have good water, they will last a number of years, and, if there is bad water, the life is very short.

Andrew S. Green, Big Four: I do not believe you can put a 5-inch end on there, and the next time put a 6½-inch end, or your tube will be too short for the boiler. If you cut the ragged end off, it will be too short. You have to have more than 1 inch, there. I do not think that will work at all. If you put a 5-inch end on there, as you say, and next weld with 6½, you must have more metal or the tube grows too short for the boiler. You will have to have 7 inches on there.

A. N. Lucas: I believe that the best method of safe-ending is, after the tubes have made their first run, without any beads, to apply a 5 or 5½-inch piece at the first safe-end, and when it has made the mileage and comes in, you cut the tube again for welding. That is an extra operation that you can do in the fraction of a minute, and then put the next safe-ends on the opposite end and you still have left, when you cut the tube, enough to go into the boiler—about 4 inches of the first safe-end, and that will give you a good safe-end into the front end and avoid any cracking of the tube. The next time the tubes are taken out, having made the mileage, you cut the tubes to the length for welding and cut off the original weld and put on a piece and it again goes into service with only three welds. On every third operation, you lose a weld. We run for ten or twelve years with only two welds, most of the time, on a tube.

H. J. Wandberg: This report deals with the life of the superheater tube. Now the life of the tube depends somewhat on the number of pieces, and how we apply them. What I would like to know about all this is what the scrapping weight of the superheater tube is?

T. F. Powers: I want to disagree with the report to the extent that I do not believe it is possible, as Mr. Green says, to safe-end superheater tubes or any other kind of tubes, with only a waste of one inch and a half from one safe-end to another. As I understand this report, the first weld is to have seven and one-half, or one inch waste. Our experience has been that to properly safe-end, and even with the most rigid economy, you have to figure on a waste of at least three and one-half inches for each time the safe-end is applied. That is, if you adopt, to start with, the five-inch safe-end. The second safe-end, including the waste of the front end, in cutting off any waste necessary to cut back of the old weld, must be three and one-half inches, and, if it is only five inches to start with, that makes eight and one-half inches. I do not believe it is possible to have a variation of only one inch between the safe-ends.

T. W. Lowe, Canadian Pacific: We still continue to weld our safe-ends at the smoke box end, and I want to repeat that again, today, where we have the possibility of having a tube that will not carry a safe-end at all.

We do not have any trouble with reference to getting the superheater units to pass by the welds when we do weld on the smoke box end, and by welding on the smoke box end, we continue our standard of swaging at the back end, which is very helpful toward providing sufficient water space next to the back flue sheet.

Steam Leaks and Their Effect on Boiler Plates

THE committee after going into details and close observation find that steam leaks cause very bad defects to boiler plates and should be given attention at once and not allowed to leak. We find that when a leak is not cared for and allowed to continue leaking, it will waste away the sheet adjoining the leak, causing a weak and unsafe condition and in time will cut a hole through the sheet. We have found when a leak had not received attention at the top of the flue sheet it had cut the sheet away to such an extent as to cause a serious defect and, in some cases, where it had cut the rivet head off and blown a hole in the sheet. Under no condition should a leak be neglected to that extent, but should be given the proper attention at first appearance or starting of the leak.

It is the firm belief of the committee that a steam leak in the boiler should be given immediate attention and proper repairs made and at no time should a leak under the jacket or around the steam dome be allowed to go after it is discovered. There is no way to tell how serious the cause of the leak may be until the jacket or covering has been removed and the cause of the leak found. A leak under the jacket often has been found to be very serious and liable to cause loss of life if neglected for one day. Often a crack develops in the shell sheets along the seams and the first signs of a leak is a warning, and the committee again recommend that all steam leaks in or around the steam boiler be given first and immediate attention.

This report was prepared by a committee consisting of D. A. Lucas, chairman; D. A. Stark, and C. C. Dean.

The remainder of this session was devoted to committee reports on law, the president's address, memorials, miscellaneous details of the convention and the election of officers.

OFFICERS OF THE ASSOCIATION FOR THE COMING YEAR

President, E. W. Young, mechanical assistant to the general superintendent motive power, C. M. & St. P., Dubuque, Iowa; first vice-president, Frank Gray, tank foreman, C. & A., Bloomington, Ill.; second vice-president, Thomas F. Powers, assistant general foreman, boiler department, C. & N. W., Oak Park, Ill.; third vice-president, John F. Raps, general boiler inspector, Illinois Central, Chicago; fourth vice-president, W. J. Murphy, general foreman boiler maker, Pennsylvania Lines West, Allegheny, Pa.; fifth vice-president, L. M. Stewart, general boiler inspector, Atlantic Coast Lines, Waycross, Ga.; secretary, H. D. Vought, 26 Cortlandt street, New York; treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley, Columbus, Ohio. Executive board, three years: E. J. Reardon, district inspector locomotive boilers, I. C. C., Chicago; Henry J. Raps, general boiler foreman, I. C.; E. J. Nicholson, foreman boiler maker, C. & N. W., South Kankakee, Wis. Executive board, two years: Jeremiah Hart, foreman boiler maker, C. B. & Q., Hannibal, Mo.; K. E. Fogarty, general boiler inspector, C. B. & Q., Lincoln, Neb.; John Harthill, general foreman boiler maker, New York Central, Cleveland, Ohio. Executive board, one year: Henry J. Wandberg, traveling boiler inspector, C. M. & St. P., Minneapolis, Minn.; George Austin, general boiler inspector, A. T. & S. F., Topeka, Kan.; C. H. Browning, foreman boiler maker, Grand Trunk, Battle Creek, Mich. Chairman of the executive board, E. J. Reardon; secretary, H. J. Raps.

Officers Elected for the Supply Association

AT the business meeting held during the convention of the Master Boiler Makers' Association the following officers were elected for the Boiler Makers' Supply Men's Association:

President, Geo. R. Boyce, A. M. Castle & Co., Chicago; vice-president, J. P. Moses, Jos. T. Ryerson & Son, Chicago; secretary, W. H. Dangel, Lovejoy Tool Works, Chicago; treasurer, S. F. Sullivan, Ewald Iron Co., Chicago.

EXECUTIVE COMMITTEE

One Year: J. C. Campbell, J. C. Campbell Co., Chicago; H. F. Gilg, Penn Iron & Steel Co., Pittsburgh, Pa.

Two Years: F. J. O'Brien, Globe Steel Tubes Co., Milwaukee, Wis.; J. W. Kelly, National Tube Co., Pittsburgh, Pa.

Three Years: W. M. Wilson, Flannery Bolt Company, Pittsburgh, Pa.; A. W. Clokey, American Arch Company, New York.

At this meeting the Association passed a resolution offered by H. F. Gilg and unanimously carried as follows:

"That the Boiler Makers' Supply Men's Association give their best efforts, collectively and individually, to counteract the vicious legislation of members of the Congress and of the legislatures of the several States against the railroads."

List of Exhibitors and Supply Men at Master Boiler Makers' Convention

THE following members of the Boiler Makers' Supply Men's Association were represented at the Master Boiler Makers' Convention and held exhibits of equipment and supplies which proved of great interest to the members:

Air Reduction Sales Company, New York.—Represented by F. E. Rogers, G. Van Alstyne, W. H. Ludington, B. N. Law, J. N.

Harkins, A. Blaser, E. M. Sexton, S. H. Calender, G. M. Calmback, R. T. Peabody, E. Phelps, G. A. Rogers. The exhibit included Airco oxygen and acetylene; Airco D-B welding and cutting torches and pressure regulators; Airco D-B portable outfit; welding supplies; locomotive valve gear levers cut with camograph for Pilliod Company; demonstrations of radiograph and camograph cutting boiler flanges to height and calking angle, and handholes.

American Arch Company, Inc., New York.—Represented by T. Maher, W. E. Salisbury, J. B. Brandon, A. Sucese, C. Pfeiffer, G. Wagstaff, T. F. Kilcoyne, E. T. Mulcahy, J. T. Anthony, J. P. Neff.

American Flexible Bolt Company, Pittsburgh, Pa.—Represented by L. W. Widmeier, W. F. Heacock, C. A. Seley, J. B. Cannon, T. J. Leahey. The exhibit included general display of flexible and rigid reduced body staybolts.

American Locomotive Company, New York.—Represented by W. E. Corrigan, E. Rogers. The exhibit included Alco flexible staybolts and parts; Alco reduced body rigid staybolts.

The Bird-Archer Company, New York.—Represented by J. L. Callahan, L. F. Wilson, C. J. McGurn, C. A. Bird. The exhibit included boiler chemicals used in water treatment.

THE BOILER MAKER, New York.—Represented by George Slate, Homer Beach, L. S. Blodgett. The exhibit included sample copies of Simmons-Boardman publications.

Brown & Co., Inc., Pittsburgh, Pa.—Represented by J. B. Armstrong, L. E. Hassman, F. M. Sterrett.

Brubaker, W. L., & Bros. Company, Millersburg, Pa.—Represented by G. Mark Brubaker, C. E. Davis, W. Searls Rose.

Burden Iron Company, Troy, N. Y.—Represented by J. C. Kuhns. The exhibit included samples of solid and drilled staybolts; engine bolt iron and Burden iron rivets.

J. C. Campbell Company, Chicago, Ill.—Represented by J. C. Campbell.

A. M. Castle & Co., Chicago, Ill.—Represented by G. R. Boyce and L. J. Quetsch. The exhibit included pressed and fabricated steel; boiler and firebox plates; rivets; staybolt and engine bolt iron.

Central Steel Co., Massillon, Ohio.—Represented by Orving H. Jones.

Champion Rivet Company, Cleveland, Ohio.—Represented by G. R. Boyce, L. J. Quetsch, D. Champion, T. J. Lawless. The exhibit included Victor rivets.

Chicago Pneumatic Tool Company, Chicago, Ill.—Represented by J. M. Stayman, E. K. Lynch, H. G. Barbee, D. E. Cooke, J. D. Crowley, N. S. Thulin, J. L. Rowe, T. G. Smallwood. The exhibit included staybolt riveter; superior chipper; close quarter drill; grinders; riveting hammers; electric drills; air hoists; rivet cutters; flue rollers; reaming drills; scaling hammers.

Cleveland Pneumatic Tool Company, Cleveland, Ohio.—Represented by C. J. Albert.

The Dayton Pneumatic Tool Company, Dayton, Ohio.—Represented by A. B. Clausen, L. B. George. The exhibit included Bull Dog safety nail driver; Champion riveting hammer; new Dayton chipping hammer; universal hose couplings.

Dearborn Chemical Company, Chicago, Ill.—Represented by J. D. Purcell, Ira L. Beebe, H. B. Ross, L. O. Bowen, Nelson F. Dunn, L. E. W. Bailey.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Represented by C. H. Hobbs, H. C. Kensing, C. C. Rosser, E. E. Ertel, L. R. Phillips. This company entertained members of the Master Boiler Makers' Association at its plant.

Everlasting Valve Company, Jersey City, N. J.—Represented by R. N. Corning, J. W. Patterson, F. B. Dawson. The exhibit included the Flatplug valve.

Ewald Iron Company, Louisville, Ky.—Represented by S. F. Sullivan, R. F. Kilpatrick. The exhibit included staybolt iron; hollow staybolt iron.

The J. Faessler Manufacturing Company, Moberley, Mo.—Represented by G. R. Maupin, J. W. Faessler, F. E. Palmer. The exhibit included flue expanders and cutters.

Flannery Bolt Company, Pittsburgh, Pa.—Represented by J. Rogers Flannery, E. S. Fitzsimmons, M. McAllister, R. W. Benson, W. M. Wilson, M. Costello. The exhibit included F. B. C. and Tate flexible staybolts; a new method of testing flexible staybolts, consisting of a drilled bolt and an electrical contact indicator to insure telltale holes being open.

Gary Screw and Bolt Company, Chicago, Ill.—Represented by P. Robinson, R. W. Dierker. The exhibit included rivets and bolts.

Garratt-Callahan Company, Chicago, Ill.—Represented by J. G. Barclay, W. Caspers, A. H. Hawkinson, W. J. Rowe.

Huron Manufacturing Company, Detroit, Mich.—Represented by H. N. Reynolds, W. H. Bentley, E. H. Willard, W. C. Jacobs. The exhibit included washout plugs; arch tube plugs.

Globe Steel Tubes Company, Milwaukee, Wis.—Represented by F. J. O'Brien, J. W. Floto, T. F. Clifford, A. A. Loeffler, R. R. Lally, J. S. Bradshaw. The exhibit included 30 samples of locomotive boiler tubes, arch tubes and superheater tubes; safe ends; stationary boiler tubes; seamless steel bushing stock for motion parts of locomotives.

Independent Pneumatic Tool Company, Chicago, Ill.—Represented by V. W. Robinson, H. G. Keller, W. A. Nugent, I. T. Cruice, C. A. Novinger, Blair J. Leslie. The exhibit included pneumatic tools and electric drills.

Ingersoll-Rand Company, New York.—Represented by J. S. Thompson, W. C. Taylor, G. C. Williams.

Wm. H. Keller, Inc., Grand Haven, Mich.—Represented by J. Conway, Mike O'Connor, C. Humphrey. The exhibit included pneumatic tools.

Key Bolt Appliance Company, Orchard Park, N. Y.—Represented by W. K. Miller, R. T. Hanscom. The exhibit included new type fitting up bolts especially adapted for boiler makers and railroad car construction work.

Liberty Manufacturing Company, Pittsburgh, Pa.—Represented by H. A. Pastre, W. R. Danley, W. W. Turner. The exhibit included Liberty type air, water and steam operated tube cleaners; Lagonda type air, water and steam operated tube cleaners.

Locomotive Firebox Company, Chicago, Ill.—Represented by C. M. Rogers, Harry Clewer, Jr.; E. J. Reardon, A. A. Taylor, C. A. Seley, B. E. Larson. The exhibit included Nicholson thermic syphons.

Lovejoy Tool Works, Chicago, Ill.—Represented by W. H. Dangel. The exhibit included frictionless roller expanders; all-steel roller expanders; Dixon multiple roller expanders; sectional tube expanders; flue-hole cutters; clover leaf staybolt sets; railroad flue cutters; "Leolok" lock nuts; beading tool retainers; journal jacks.

Lukens Steel Company, Coatesville, Pa.—Represented by Harry Loeb, L. J. Quetsch, G. R. Boyce. The exhibit included firebox and boiler steel.

McCabe Manufacturing Company, Lawrence, Mass.—Represented by F. H. McCabe. The exhibit included working models of pneumatic flanging machine, together with flanged flue sheets.

National Tube Company, Pittsburgh, Pa.—Represented by G. N. Riley, J. W. Kelly, R. J. McAuliffe, P. J. Conrath. The exhibit included sample pieces showing crushing, flattening, expanding and beading tests; also methods of expanding and beading of large superheater 2-inch and 2¼-inch tubes into back tube sheets.

Otis Steel Company, Cleveland, Ohio.—Represented by G. E. Sevey.

Oxweld Railroad Service Company, Chicago, Ill.—Represented by W. A. Hogan, W. A. Champieux, H. W. Schultz, A. N. Lucas, J. Keegan, F. C. Hasse, C. S. Wright, H. A. Gigandent, Otto Ladtkow, W. H. Thompson, G. R. Lichty, William Jones. The exhibit included Oxy-acetylene welding and cutting equipment.

Parkesburg Iron Company, Parkesburg, Pa.—Represented by W. H. S. Bateman, U. R. Wetherald, U. F. Wiese. The exhibit included section of charcoal iron boiler tube having been in service *42 years;* sections of tubes showing various master mechanics' tests—crushing, flanging and expanding.

Penn Iron & Steel Company, Creighton, Pa.—Represented by Henry F. Gilg. The exhibit included samples of staybolt iron; drilled hollow staybolts up to 24 inches long, bars as tested for U. S. Navy.

The Prime Manufacturing Company, Milwaukee, Wis.—Represented by D. A. Lucas. The exhibit included malleable and brass washout plugs.

Rome Iron Mills, Inc., New York.—Represented by C. C. Osterhout. The exhibit included Superior staybolt iron; perfection engine bolt iron; Rome hollow iron.

Jos. T. Ryerson & Son, Chicago, Ill.—Represented by J. P. Moses, A. W. Willcuts, C. F. Barton, E. W. Kavanagh, L. D. Hiner. The exhibit included Ulster special seamless hollow staybolt iron.

Scully Steel & Iron Company, Chicago, Ill.—Represented by J. W. Patterson, E. N. Corning, L. Verschum. The exhibit included tube expanders; tube cutters; flaring tools; staybolt taps; staybolts; reamers; welding flanges; flat plug valves for roundhouse installation.

S. Severance Manufacturing Company, Glassport, Pa.—Represented by F. W. Severance, F. G. Pfahl. The exhibit included rivets of several different sizes, shapes and specifications, and a new type combination oil and gas burner, which is just being brought out.

The Superheater Company, New York.—Represented by G. E. Ryder, R. M. Ostermann, K. E. Stilwell and R. J. Van Meter.

The Talmage Manufacturing Company, Cleveland, Ohio.—Represented by Frank M. Roby, Herman B. Thurston. The exhibit included Cleveland low-water alarm; Talmage blow-off valve, drifting valve, hand-brake, ash pan.

Thomson Electric Welding Company, Lynn, Mass.—Represented by R. M. Taylor, F. H. Leslie, F. E. Taylor. The exhibit included samples of electric welded flues; photographs of the three types of railroad flue welders; newly issued special railroad flue welder bulletin.

Torchweld Equipment Company, Fulton and Carpenter streets, Chicago, Ill.—Represented by W. A. Slack, A. W. Fry. The exhibit included oxy-acetylene cutting and welding equipment; machine and hand cutting torches; machine and hand welding torches; regulators, accessories and supplies.

U. S. Light and Heat Corporation, Niagara Falls, N. Y.—Represented by H. A. Morrison, Ernest Bauer. The exhibit included electric arc welding machines; samples of various types of electric welds.

The Weldless Tube Company, Cleveland, Ohio.—Represented by C. A. Dunn, O. H. Larwill. The exhibit included seamless steel tubing.

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Boiler manufacturers report that in the last six or eight months they have been obliged to reject an unusual number of laminated boiler plates. These defects, in many cases, do not show up until the plate has been nearly fabricated in the boiler shop and the only recourse is to send to the mill for another plate and repeat the shop operations, which means a loss of time and money for the manufacturers not to mention the possibility of undetected hidden defects in plates that pass inspection and go into the finished boilers.

Such defects are very serious and it is up to the steel makers to remedy the situation. Laminations may be due to poor workmanship or to imperfect methods of manufacture in the steel mills. Whatever the cause, they should not be tolerated in materials for pressure work. Experience has shown that American steel makers are capable of turning out the finest grade of boiler plates and in boiler work nothing else is acceptable.

One line of business which boiler manufacturers apparently have neglected to follow up is the supplying of repair parts for equipment which they have sold. If the user of the boiler is left to his own resources, the chances are that in nine cases out of ten, when some repair part is needed, he will go to the nearest local foundry or boiler shop and get something as quickly as possible to replace the broken part regardless of whether it will serve his purpose as efficiently as a replacement part from the original manufacturer. In such instances it is obvious that the manufacturer should not be blamed for any falling off in the efficiency of the boilers as the repair parts supplied by another firm may not work efficiently with the original installation, whereas if the repair part were supplied by the manufacturer himself the efficiency of the plant would not be reduced. Furthermore, the manufacturer might find the sale of repair parts a profitable line of business, well worth the effort required to secure it.

If all indications are correct, this year's convention of the Master Boiler Makers' Association at Detroit will open a new era of progress and prosperity to the association. In point of numbers, the attendance was slightly below that of last year but the spirit of earnestness with which the business of the convention was transacted made the meetings as successful as any ever held by the association. Almost without exception, every member was in his seat when the president opened the sessions of the convention and remained until the work of the meetings was completed.

About two hundred and fifty members of the association were not at the convention for one reason or another. In some cases distance, press of work, or personal affairs made it impossible for them to attend, but this probably applies to very few. Fortunately, with few exceptions, the association has the endorsement and direct support of the heads of the mechanical departments of the railroads of the United States and Canada and their complete cooperation in this matter can be counted upon, so that by another year those who were not in attendance will no doubt be required to come by their superiors.

Probably the most far reaching decision made by the association was that increasing the annual dues to five dollars. The expense of conducting the affairs of the association has been increasing much faster than the income, due to higher printing costs, the expense of the conventions, and the like, and some action to provide additional funds at this time was necessary. From now on the financial condition of the association will be on a firmer basis which will make possible the broadening of scope of its activities with a corresponding increase in its value to members.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Portable Electric Rivet Heaters

THE latest types of electric rivet heaters, manufactured by the Humil Corporation, New York, have a number of distinctive features, the most important of these being flexibility in operation, permitting the efficient heating of a wide range of sizes without the usual burning of the smaller rivets on machines of the higher ratings, and at the same time permitting the heating for non-continuous service of the largest rivets on the smallest machines.

Low power consumption, or high efficiency, has been secured by generous proportioning of copper and iron in the special type transformer, also by heavy cross sections in the long flexible leads that are autogenously welded into the pure copper electrodes or heads.

Regulation against heavy power surges on starting the heating action, and the maintenance of high power factors (79 to 94), are obtained by means of air gaps in the transformer magnetic circuit. The high efficiency and power factor is also maintained through placing the transformer low in the machine and remote from the radiated and conducted heat from the rivets. Air spaces, provided between the coils, permit a constant stream of cold air to pass up through the transformer, cooling it constantly and enabling it to maintain high efficiency all the time that it is under continuous full load.

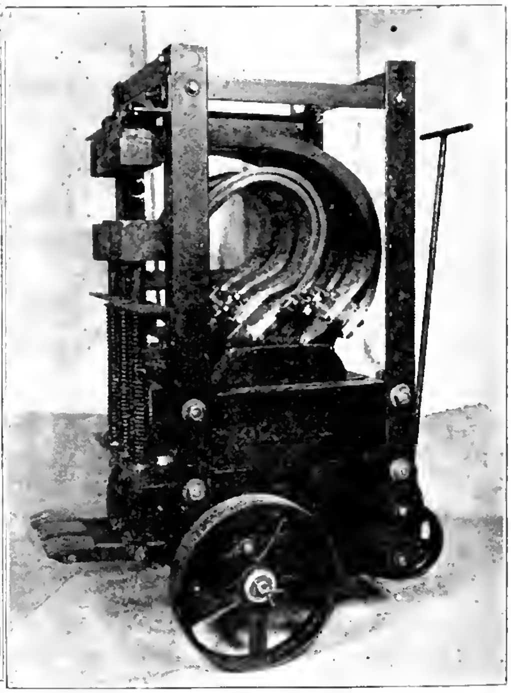
All of the coils are positioned around a separate center core, the secondary coils of heavy cast copper completely enclosing the core, except for a small gap at the top to provide the open circuit necessary. This design provides for the complete cutting of all magnetic lines by both primary and secondary coils. The primary coils are wound with bare strip copper, insulated with asbestos and mica tape. This provides for rapid dissipation of the heat to the vertical air spaces and at the same time eliminates high voltage between layers of windings.

Stability and portability are secured in the Calorac heaters by keeping the center of gravity low in the frame and mounting the machine on large traction wheels. Provision has also been made for lifting by crane.

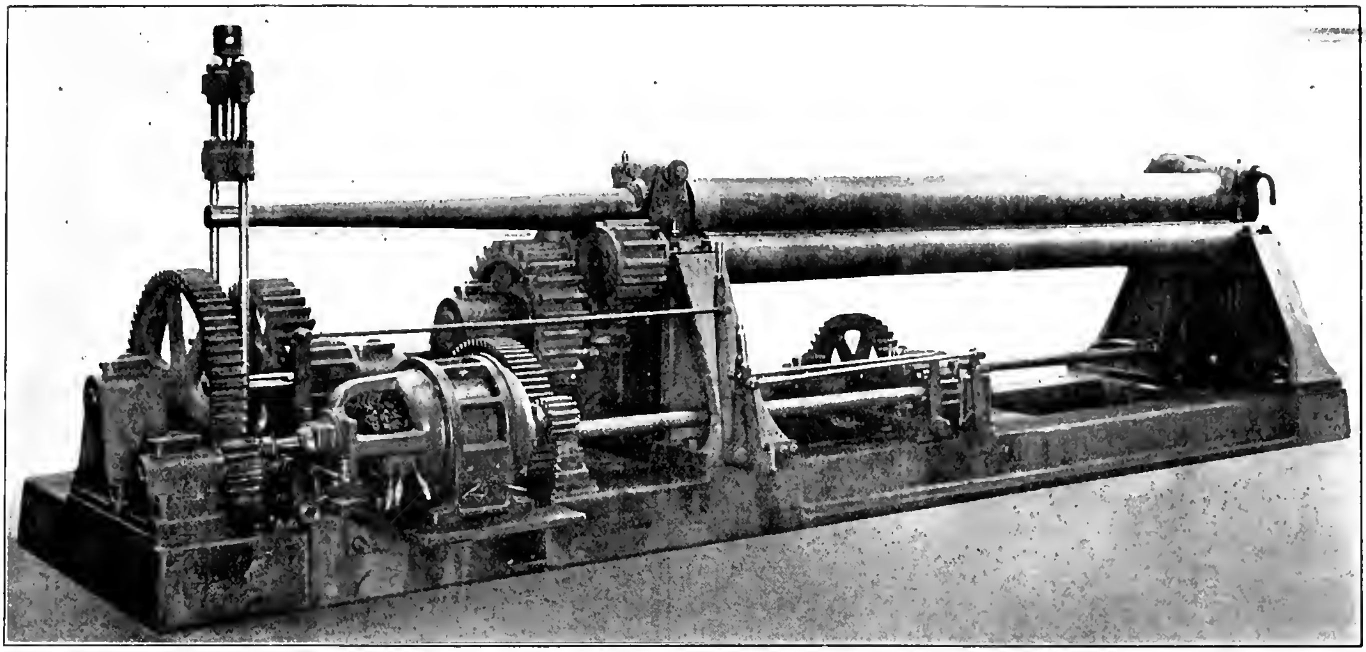
Close regulation of the power applied to the rivets is obtained by a five-speed controller, so mounted as to be readily accessible to the operator, thus permitting him to govern his production rate accurately. On the smallest two-contact Type A-2-H machine, rivets 1/4 inch by 1 inch can be heated at the rate of 720 per hour, while in the same machine rivets 5/8 inch by 2 1/4 inches are said to have been heated at the rate of 150 per hour. This same machine is also capable of heating much larger rivets. The large Type C heaters, when equipped with three or five sets of heating contacts, are capable of reaching a high production of hot rivets of the largest sizes. These machines are well adapted to heating the large mudring rivets used in locomotive boilers and other special sizes.

Safety of the operator is secured by the shielding of all live primary parts, while the electromotive force at the heads is so low that it cannot be felt by bare hands, this voltage never exceeding 3 volts. The machine is designed to be fool-proof and fire-proof. The comfort of the operator as well as that of other men in the shop is assured by the absence of smoke and fumes, with a resultant favorable effect on output.

Calorac 3-Head Portable Rivet Heater on Boiler Work



Riveter with Side Plates Removed



Power Bending Rolls Recently Made by the Cleveland Punch & Shear Works Company

Direct-Connected Motor-Driven Bending Rolls

The illustration shows a No. 2 Cleveland pyramid type bending roll, spaced to 10 feet 2 inches between housings, recently designed and built by the Cleveland Punch & Shear Works Company, Cleveland, Ohio.

This machine is direct connected, motor driven, entirely self-contained and is arranged for power raising and lowering of the top roll. One of the lower rolls (8 inches in diameter) has three splines; the other lower roll has two splines and a flanging groove. The upper roll is 11 inches in diameter. It will be noticed that none of the gears protrude into the foundation, hence no expensive pit is required. Two clutches are provided so that either end of the top roll may be raised and lowered. An additional single clutch is used for starting the rolls.

This bending roll, as shown in the illustration, is featured by rigid construction and parts so proportioned as to stand the stresses imposed on them with an ample factor of safety. The roll boxes, yoke and elevating screws are all scientifically designed and made with a view to strength and durability.

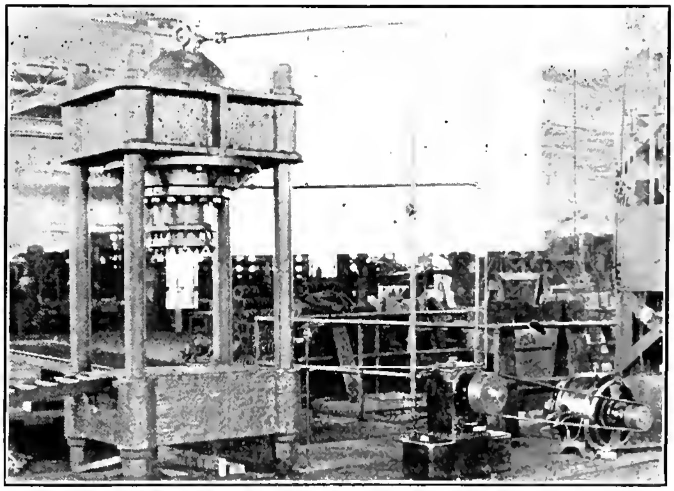
When it is desired to drop the hinge at the right end, the cover plate can readily be lifted from the shoulder belts and the yoke dropped by one man.

Variable-Speed Drive for 150-Ton Press

The advantages claimed for hydraulic variable-speed drive in perfect control of speed, absence of coasting, elimination of peak loads and low maintenance have been demonstrated in the 150-ton press installation illustrated. This press has been equipped recently with hydraulic variable-speed drive by the Oilgear Company, Milwaukee, Wisconsin.

The type W Oilgear variable delivery pump which operates this press (shown in the right foreground of the illustration) is well adapted to these conditions. The control handle at the corner of the press is so connected to the pump that the pump stroke can be varied from zero to a maximum in any direction. Changing the length of the pump stroke regulates the amount of oil that is pumped into the press cylinder and thus controls the movement of the ram with great accuracy.

This pump is featured by light weight and takes up considerably less room than a water pump. It is driven by a constant speed electric motor. The diameter of the press cylinder in this case is 19 inches the ram diameter being 10 inches.



Type W Oilgear Variable-Delivery Pump Driving 500-Ton Press

Locomotive Conditions in April Best Since July, 1922

Interstate Commerce Commission's monthly report to the President is the best since July, 1922. In April 5,266 locomotives were inspected by the Bureau of Locomotive Inspection, of which 3,049, or 58 per cent. were found defective and 511 were ordered out of service. The percentage of those inspected found defective is the lowest that has been reported for any month since the shopmen's strike began last July.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Introducing Tanks into Buildings Having Small Openings

Q.—What is the best method of introducing a tank into an old building through an opening smaller than the diameter of the tank? We have this problem arise quite frequently where it is necessary to get a tank into an old building without cutting new openings in the building walls. One specific problem which we are handling at the present time is to introduce fourteen 42-inch by 12-foot tanks into as many existing buildings through 36-inch by 36-inch openings which cannot be cut. The best solution which we have found is to roll the sheets up in one piece to a diameter of 39 inches and then squeeze the shell to a diameter of 35 inches and hold it in this condition with wire bands. The tanks are then introduced into the buildings, where the shells are opened up, the heads introduced and the joints welded. The heads are bumped and flanged so as to set into the shell and the longitudinal joint of the shell is lapped 2 inches. These joints are then all bolted with erection bolts on about 2-foot centers to hold the assembled tank in place, while the head and shell joints are welded inside and outside. We find that riveting tanks on the job which have been brought into the building knocked down is generally prohibitive on account of the noise. We should like to know what experience your experts have had with this problem and be advised of any improvement which you might have to suggest over the scheme which we are using.—P. W.

A.—Your method of preparing the sheets and introducing them into the building, seems to us the only solution in view of the circumstances mentioned.

We would, however, be pleased to hear from our readers on this problem.

Effect of Temperature Changes in Water

Q.—Would you please answer this question. The maximum density of water is said to be at 39.2 degrees F. Why does it expand just at that point, i. e., above that point and contract below that point? What are the fundamental principles of the chemical change? I have read a lot on steam, but have never seen any book that explained why water changes its density at that point.—W. R.

A.—Water expands and contracts with the changes in temperature. The temperature at which water freezes is 32 degrees F. If the water is cooled below that point it expands and its density decreases or if the water is heated from 32 degrees to 39.2 degrees F. it contracts instead of expanding and its density increases until it reaches the maximum density at 39.2 degrees F. This action which is unexplainable is an advantage in nature, for otherwise deep rivers and lakes would freeze to the bottom and thaw only on the surface during the warmer seasons. As the colder weather takes place the water gives up some of its latent heat by radiation and its temperature falls, as a result the cooler water circulates or settles to the bottom. This condition continues until the entire body of water has reached a temperature of 39.2 degrees F. Further cooling of the water arises on the surface which expands and its density becomes less. After the surface water has reached 32 degrees F., 142.6 units of heat must be radiated by each pound of water before reaching the freezing point.

Water being a poor conductor of heat, it would take a long time for the water at the bottom to give up its heat, for that reason in temperate zones under severe winters, ice does not form to the bottom of the lakes and rivers and at the bottom the water is never colder than 39.2 degrees F.

Gusset Sheet Layout

Q.—I have tried time and time again to develop the gusset plate as shown on page 71 of the third edition of "Laying Out for Boiler Makers" and have had no success. I do not understand how the points 1_2, 2_2, etc., and 1^0_2, 2^0, etc., are established above the line *E-E*. Also Fig. 16 puzzles me, for I do not see where the lines and distances *a-b-c*, etc., and 1-2-3 are found or established. Please send me the solution as soon as possible, for I want to use it; also if there are other ways of working this gusset plate out please give me the same. Please send me the most accurate method of laying out a cone-shaped barrel sheet.—C. W. C., Jr.

A.—Fig. 1 will illustrate the development of a gusset sheet as made in the form of a scalene cone. The solution is the same as described on page 71 "Laying Out for Boiler Makers." The outline of the gusset sheet is indicated between the reference letters *a, f, l, g*. The side *a-g* is extended and the side *l-f*, drawn to meet it in the point *x*. Locate the center of the sides *a-f* at *o* and *g-l* at *m*. With *o* and *m* as centers describe the semi-circle as shown for the large and small bases or ends. Divide them into any desired number of parts as indicated at *a, b, c*, etc., for the smaller semi-circle, and *g, h, i*, etc., for the larger. With *a* as a center draw arcs from *b, c, d* and *e* to intersect the base line *a-f*, thus locating points b_1, c_1, d_1 and e_1. With *g* as a center and from points *h, i, j* and *k* draw the arcs as indicated. Determine the arc lengths between the points on each semi-circle by drawing a straight line equal to the length of each semi-circle. Divide each line into the same number of parts as contained in the semi-circle, in this case 5. The respective length between any two points on each line is used for developing the pattern.

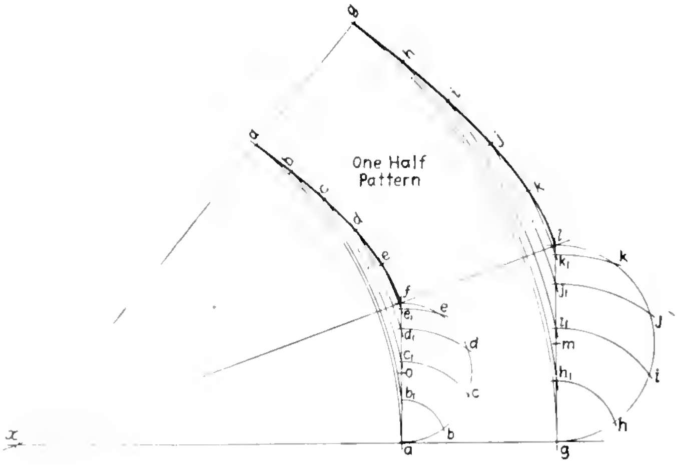


Fig. 1.—Development of Gusset Sheet

One-half of the pattern is also shown in Fig. 1. From point *l* and with the dividers set to the arc length for the spaces at the large end draw an arc. With x as a center, and the trammels set to x-k_1 draw an arc to intersect the one drawn from point l. With k as a center and with dividers set to k-l draw an arc. With x as a center and the trammels set to x-l draw an arc to intersect the arc previously drawn, thus locating point j. Continue in this manner until the pattern is complete.

Efficiency of Boiler Seams

Q.—I am about to make reports on several miniature boilers and am at a loss to know of a formula to figure on the efficiency of same where the boiler sheet is a piece of commercial pipe obviating the necessity of a longitudinal rivet joint such as are in the construction of the Hoffman, the Prosperity, the Oldfeldt and the Eclipse Fuel Engineering Company.—R. B.

A.—The following formula is given by the A. S. M. E. Code in their latest revision which is applicable in determining the allowable pressure on pipe.

Thickness of Steam Pipe.—In determining the thickness to be used for pipes at different pressures and for temperatures not exceeding 700 degrees F. the following formula is to be used:

$$P = \frac{2S(t - 1/16)}{D} \qquad (1)$$

in which

P = working pressure in pounds per square inch.
t = thickness of pipe wall, inches.
D = inside diameter of pipe in inches.
S = 3,500 pounds per square inch for seamless steel pipe.
3,200 pounds per square inch for lap-welded steel pipe.
2,500 pounds per square inch for butt-welded steel pipe.
2,500 pounds per square inch for lap-welded iron pipe.
2,000 pounds per square inch for butt-welded iron pipe.
2,000 pounds per square inch for brass pipe.
2,000 pounds per square inch for copper pipe.

By transposing the factors in the preceding formula to find the required thickness of the wall of the pipe, the following formula for

$$t = \frac{DP}{2S} + \frac{1}{16}. \qquad (2)$$

To determine the allowable working pressure for an 18-inch seamless steel pipe ¼-inch in thickness, substitute the values in formula (1)

Then:

$$P = \frac{2 \times 3{,}500\ (1/4 - 1/16)}{18} = 72.9 \text{ pounds per sq. in.}$$

As the required working pressure equals 100 pounds per square inch, the thickness of the pipe wall must be increased. Use the formula (2) and substitute the given values.

Thus:

$$t = \frac{18 \times 100}{2 \times 3{,}500} + \frac{1}{16} = 0.32 \text{ inch.}$$

Boiler Repair Methods at Columbus

(*Continued from page 154*)

of such sizes and thickness as are required on most of the locomotives.

The welding and cutting department which works in close cooperation with the boiler shop is under the control of one of the ablest welding foremen in the country and the results, both in speed and quality of work, on firebox repairs, flue installation and the like are largely due to his efforts.

Further details of repair methods and special jobs carried out at Columbus will appear in an article to be published in the July issue of The Boiler Maker.

OBITUARY

Clyde Mitchell Carr, until recently president of the iron, steel and machinery firm of Joseph T. Ryerson & Son, Inc., died on June 5 at his residence 1130 Lake Shore Drive, Chicago. Mr. Carr was born in Will County, Illinois, July 7, 1869. For twelve years Mr. Carr was president of Joseph T. Ryerson & Son, Inc. On account of poor health he had been unable to take an active part in the management of the firm for the past four years and last January resigned as president, although continuing until the time of his death as a member of the board of directors. Mr. Joseph T. Ryerson succeeded Mr. Carr to the presidency. Mr. Carr became associated with the Ryerson organization in 1890. From 1904 he took an active part in the management of the firm's affairs and in 1911 was elected president. Mr. Carr was always an active leader in civic and industrial circles and his far reaching influence accomplished much wherever he was interested.

Clyde M. Carr

BUSINESS NOTES

Joseph W. Hays is just completing the organization of a corps of consulting combustion engineers to be known as Jos. W. Hays and Associates. The headquarters of the organization will be Michigan City, Indiana.

The Detroit Steel Products Company, Detroit, Mich., will establish a branch factory at Emeryville, Cal., which will have 83,000 square feet of space. A. Lum has been appointed manager of the plant and will have charge of sales on the Pacific Coast.

Paul H. Brangs, for many years in charge of the New York office, Heine Boiler Co., St. Louis, has retired, and George F. Murphy, formerly Pittsburgh manager, will have charge of the New York territory, assisted by J. L. Daly and G. A. Knowles. Headquarters will be at 11 Broadway.

O. C. White, manager for the past two years at Fort Worth for the Youngstown Boiler & Tank Co., has been appointed general sales manager for the company, with headquarters at the home office in Youngstown. A. L. Scudder, formerly district sales manager for the Graver Corporation at Fort Worth, Tex., has resigned and accepted the position made vacant by Mr. White's promotion.

The Surplus Steel Exchange, Inc., has been formed for the purpose of presenting an outlet for surplus stock material of steel products. A commission will be charged only on sales actually made, as the exchange will not buy material but act solely in the capacity of agent. The officers of the new company are: Robert D. McCarter, president; George E. Dix, vice-president; William L. Cooper, treasurer, and Edward Michaud, secretary and general manager. The offices are at 7 Dey street, New York City.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Oil Storage Tank Failure

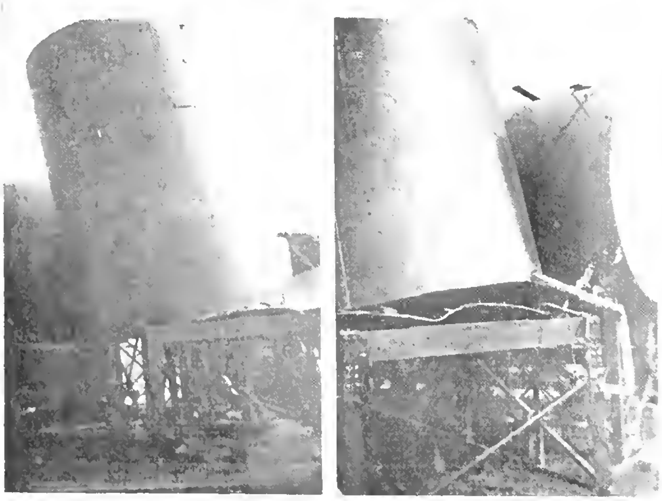
On Monday morning, April 10, about 8,000 gallons of kerosene spilled as the result of the bottom of a tank opening all the way around. This tank was welded throughout with a shell $\frac{1}{4}$ inch thick and bottom $\frac{3}{8}$ inch thick reinforced with three 6-inch channels tacked with a torch. The top was apparently of 3/16-inch material and the welds were evidently very poor, only about 2 percent being good, as the plate broke at these points and showed very brittle; also the welds showed brittle and poor fusing all the way around.

The tank was being filled at the time with a pump; evidently there was no vent and naturally there was a pressure of sufficient force to cause the welds to open as shown in the accompanying illustrations.

The tank was moved to one side about 18 inches. One man, Robert Minnette, truck driver, was near, getting ready to fill his tank when the accident occurred, and he was thrown down and nearly drowned and was taken to the hospital with a wrenched back.

Evansville, Ind. E. Wotring,

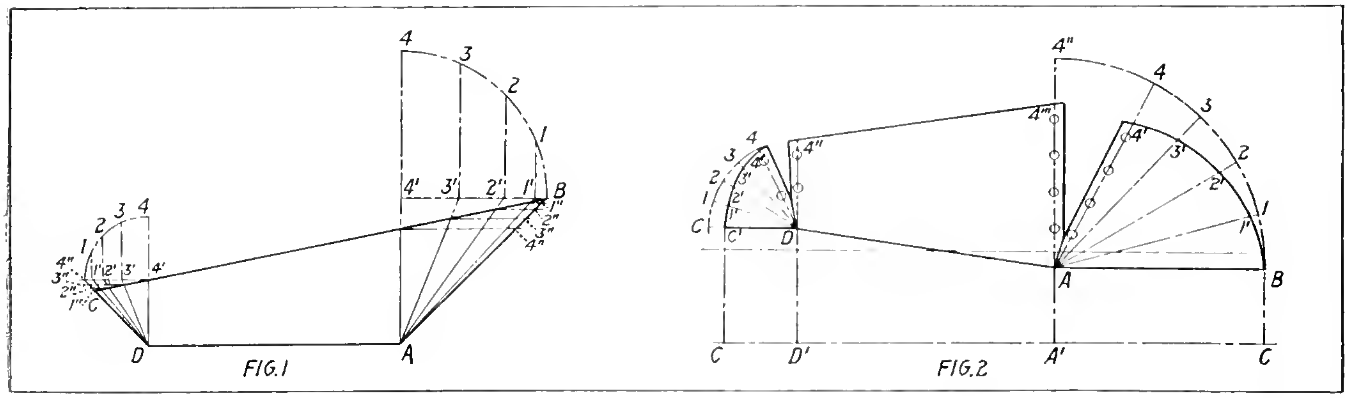
Insurance Department, Mercantile Commercial Bank



Views of Opening in Bottom Seam of Storage Tank Which Failed

Layout of Wheelbarrow Body

In developing the wheelbarrow body shown in the accompanying sketches first draw an elevation of the body as at *A, B, C, D*, Fig. 1. From *A* draw *A*-4 at right angle to *A-D*, from *B* draw *B*-4′, at right angles to *A*-4; from point 4′, as a center and 4′-*B* as a radius draw the quadrant *B*-4. Divide this quadrant into any number of equal spaces as 1, 2, 3, 4. From 1, 2, 3, 4 draw lines parallel to *A*-4 to line *B*-4′ locating the points 1′, 2′, 3′. Draw lines *A*-1′, *A*-2′, *A*-3′. Where these lines cross the line *B-C* draw lines parallel to *B*-4′ out to the line *B-A*, locating the points 1″, 2″, 3″, 4″. These are the true lengths of the construction lines *A*-1′, etc., and can be used as such in the actual layout.



Details of Special Sheet Metal Wheelbarrow Body

Pattern Development

To lay out the pattern draw the center line *C-C*, Fig. 2. On the line *C-C* lay out one-half the plan of the bottom of the body as shown at *A-D-D′-A′*. Draw *A-B* parallel to *A′-C*. With *A* as center and *A-B*, Fig. 1, as radius, draw the quarter circle *B*-4″. With the dividers set equal to one of the spaces *B*-4, Fig. 1, from *B* step of the four spaces 1, 2, 3, 4. Draw the lines *A*-1, *A*-2, *A*-3, *A*-4, make *A*-1′, *A*-2′, *A*-3′, *A*-4′, *A*-4‴ equal to *A*-1″, *A*-2″, *A*-3″, *A*-4″, Fig. 1. A line drawn from *B* through the points 1′, 2′, 3′, 4′ will give the circumference of the quarter circle at the top corner of the body. Locate the rivet holes on the lines *A*-4′, and *A*-4‴. Make the necessary allowance for lap. The small end and the other half of large end are laid out in exactly the same manner.

Amarillo, Texas. J. W.

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William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

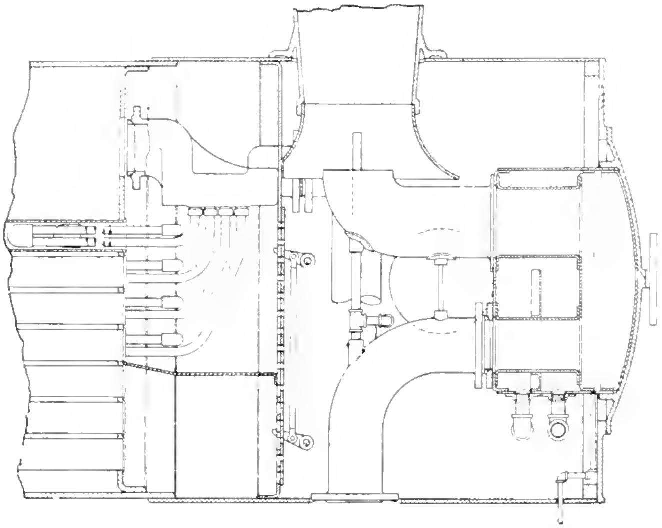
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,454,161. LOCOMOTIVE. MARTIN J. FURLONG, OF HOUSTON, TEXAS.

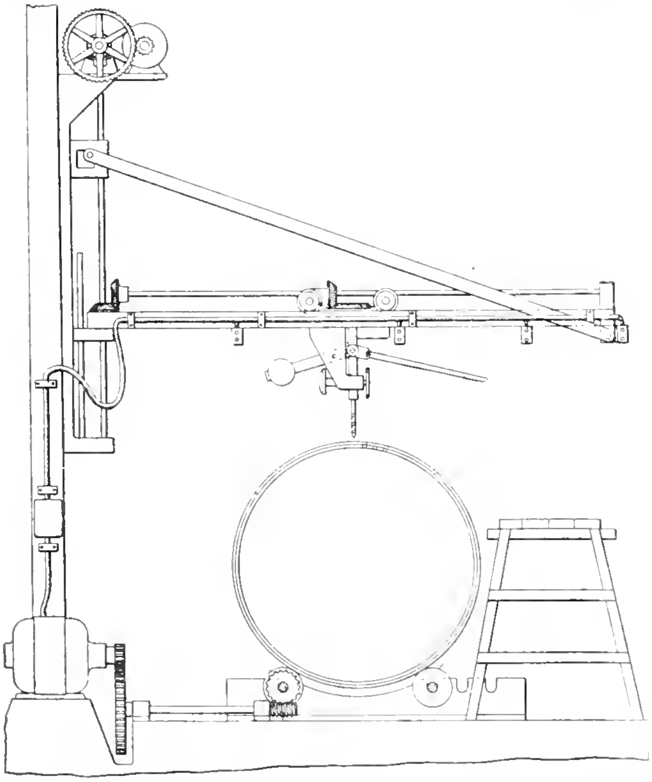
Claim 1.—In a locomotive, a superheater chamber, a front end chamber, a partition plate arranged in front of said chamber and provided with draft outlets, a movable damper plate arranged adjacent the partition plate and



provided with openings, opposite each of said chambers, means for automatically actuating the damper plate, and means for manually limiting the range of movement of the damper plate. 4 Claims.

1,453,705. BOILER-TURNING CRADLE. JAMES CROMBIE, OF ST. LOUIS, MISSOURI.

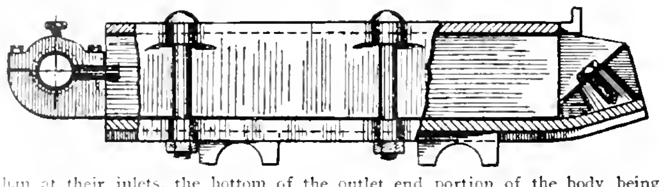
Claim 1.—In combination, a boiler-turning cradle for a drill press comprising a set of supporting rolls two of which are connected to rotate as a



pair, a reversible electric motor connected to said pair of rolls to positively rotate the same in either direction, and controls for said motor located on the drill press convenient to the drill controlling mechanism. 2 Claims.

1,455,429. FURNACE OF STEAM BOILERS. THOMAS COLLIER, OF COLNE, ENGLAND.

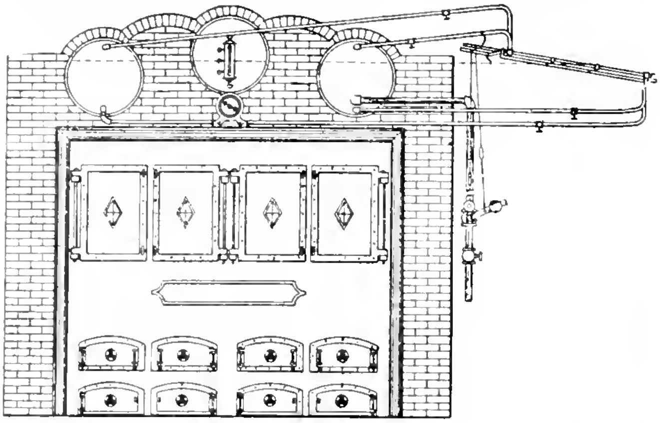
Claim 1.—A Bunsen blower, adapted to be secured under the dead plate of a furnace, comprising a fan-shaped body open at each end and divided by partitions into a series of compartments which are wider at their outlets



than at their inlets, the bottom of the outlet end portion of the body being inclined upwardly beyond the rear ends of the compartments, a deflecting plate secured over the inclined end portion and arranged at a steeper angle than it, and a steam pipe arranged crosswise of the open inlet of the body and having a series of nozzles which project into the air inlet openings of the compartments. 2 Claims.

1,454,146. BOILER FEEDWATER REGULATOR. ROGER W. ANDREWS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO NORTHERN EQUIPMENT COMPANY, OF ERIE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

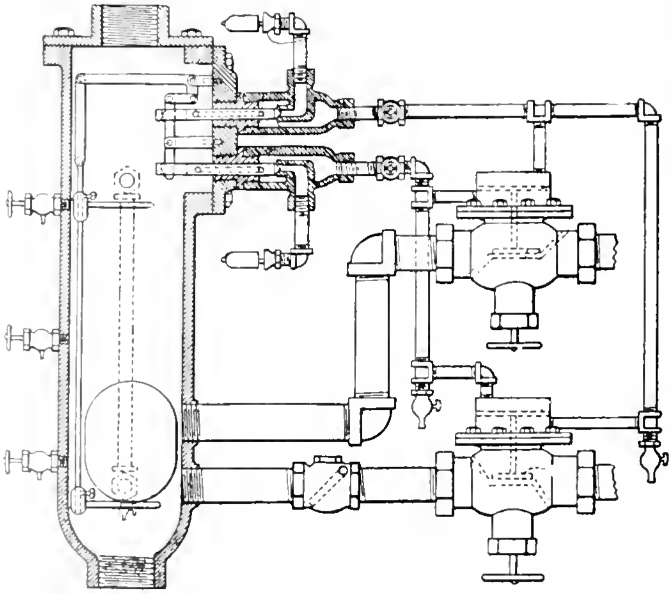
Claim 1.—The combination of a boiler, two feedwater regulators and a feedwater valve, said valve comprising a plunger and a seat therefor, said plunger and seat being relatively movable rotationally and longitudinally, the first of said feedwater regulators being operatively connected with said boiler and with said valve and arranged to move said plunger and seat



relatively longitudinally, and the second of said feedwater regulators being operatively connected with said boiler at a portion of said boiler remote from the point of connection of said first regulator, said second regulator being also operatively connected with said valve and adapted to move said plunger and seat relatively rotationally, said plunger and seat when in one relative position forming an opening through said valve, and said opening being varied as said plunger and seat are moved relatively either rotationally or longitudinally. 3 Claims.

1,455,211. BOILER WATER LEVEL CONTROLLER. JOHN F. KELLY, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KELLY VALVE COMPANY, OF MUSKEGON, MICHIGAN, A CORPORATION OF MICHIGAN.

Claim 1.—In a boiler water level controller, the combination of a casing, a float therein, a water supply pipe, a water delivery pipe, valves in said pipes, steam actuated means for operating said valves, manually operable



means for actuating said valves independently of said steam actuated means, valves for controlling the supply of steam to said steam actuated means, and an operative connection between said float and each of said last mentioned valves. 10 Claims.

THE BOILER MAKER

JULY, 1923

Boiler Repair Practice in M. C. Shops at Jackson

THE average boiler maker is seldom given an opportunity to visit the shops of railroads other than his own, yet there is no better education available for a good boiler maker than a chance to study the methods used by others of his trade. Practically the only way then for the work of shops in general to be brought before the men in the shops is through the medium of the trade journal. With this thought in mind, THE BOILER MAKER is trying to supply information on some of the work of the more important repair shops in the country. The following article, for example, outlines some of the methods employed in the boiler shop at Jackson, Mich., including a record of oxy-acetylene cutting work which compares favorably with that of any shop in the country.

IN the Jackson shops the greater part of the locomotive repair and maintenance of the Michigan Central Railroad is carried out, which means that the boiler shop is generally working at capacity. This capacity seems to be an adjustable factor for when boilers are needed they always go through in whatever quantity is required by the schedule system which operates at this plant. This system acts as pacemaker for the entire works and, to a certain extent, its functioning depends on the boiler shop.

How the Schedule Works

In order to understand how the work of the shop is carried out it is first necessary to become familiar in a general way with the schedule system. In the course of the routine business of the mechanical department, a meeting is held by the shop superintendent, master mechanic and other mechanical officials to determine what locomotives are due for shopping for classified repairs during a given month. Running reports, inspection reports and general service records are used as the basis for these determinations. The classification used is according to the 5-class standard adopted by the United States Railroad Administration which is in vogue on most railroad systems. From the findings of the mechanical department an outline of light, medium and general repairs with details of what the repairs shall consist is prepared and sent to the production department.

The foreman of this department lays out on a master schedule board the dates for every operation that will be required on the engines coming into the shop the following month, insofar as they apply to departments other than the boiler shop. Then about the twenty-third of the month a joint meeting of the shop foreman and the schedule or production department foreman and his assistants is held. The sketch of the schedule board shown below will indicate the scope of the repair work covered in detail at this meeting.

An explanation should be made at this point of the omis-

Fig. 1.—A Corner of the Boiler Shop

Engine No.	Date In	Front End Stripped	Flues Out	Machinery Stripped and Delivered	Piston Valve Bushing Out	Jacket	Lagging Off	Frames Machined	Frames On	New Cylinders	Cylinder Bushings	Crossties	Deck Castings	Firebox	Flues Reset	Boiler Fittings	Boiler Studs	Hydrostatic Test	Steam Pipes	Superheater Arrangements	New Piston Valve Bushings	Piston Valve Bushings In	Piston Valve Bushings Bored	Rocker Boxes Machined	Rocker Boxes Up	Engine Blanked	Units Tested On Block	Unit Pipes In	Units Tested	Valves Machined	Valves In	Steam Chest and Covers Machined	Steam Chest and Covers Up	Steam Test and Blowed Out	Front End Netting	Front End Machined	Front End Up	Wheels	Eccentrics	Driving Boxes Machined	Driving Boxes On Wheels	Shoes and Wedges Laid Out	Shoes and Wedges Machined	Trailer Frames	Trailer Wheels

Fig. 2.—Master Schedule Board—The General Da

sion of practically all boiler work from the schedule. Since the assembly of the reconditioned locomotive depends on whether the boiler is ready or not, it may be said that the work of every department is gaged on the output of the boiler shop. Here at Jackson over a long period of time it has been found that boiler shop production not only goes through on time, but is ahead of practically every other department. As an example, monthly boiler shop production based on 100 percent efficiency for the month of March was 99.5 percent and for the month of April 106.9 percent. The schedule for the entire plant for March was 96.3 percent and for April 100.1 percent.

As mentioned, at the monthly meeting, department heads take down on individual department forms the dates for all work coming under their jurisdiction. From the general schedule the foreman of the boiler shop knows exactly what the requirements for his department will be for that month.

The foremen later reproduce their individual schedules on department boards in the shop and these boards, job orders and other follow-up and check work are supervised by the production foreman and his assistants. It is not necessary to go into general details of this work for it has little relation to the work of the boiler shop. However, the department is an efficient one and work is kept moving through the shop under constant check at all times.

Meetings with the production department are held every Monday, Wednesday and Friday at which time any difficulties which have arisen causing delay of work in any department are cleaned up and the system kept functioning smoothly. At this time, too, any minor repairs in the roundhouse that require immediate attention are introduced into the schedule so that there will be a minimum of interference with regular work. A great deal of the outside roundhouse work is taken care of by the boiler shop force, as maintenance work of this kind is general tightening of flues, staybolt replacement or other jobs coming under the head of boiler work.

At a meeting held about the eighth of each month the schedule is revised to take care of any work that has been carried from the previous month. Sometimes when routine

Fig. 3.—Flue Department Looking Towards Stock Room

Engine Truck	Pipes Under Jacket	Boiler Lagged	Jacket	Spring Rigging Machined	Spring Rigging Up	Reverse Shaft Boxes Machined	Reverse Shaft Boxes Up	Reverse Lever and Reach Rod Machined	Reverse Lever and Reach Rod Up	Motion Work Machined	Motion Work Up	Guides Machined	Guides Up	Crossheads Machined	Crossheads Up	Pistons Machined	Pistons In	Running Boards and Cab	Re-Wheeled	Side Rods Machined	Side Rods Up	Main Rods Machined	Main Rods Up	Eccentric Cranks Machined	Eccentric Cranks Up	Eccentric Rods Machined	Eccentric Rods Up	Brake Rigging Up	Air Brake Machined	Air Brake Equipment Up	Grates	Ash Pan	Ash Pan Operating Device	Pilot	Valves Set	Air Pump	Cab Trimmings	Cylinder Cock Cylinders	Headlight	Pipe Work	Tender Unloaded	Tender Repaired	Engine Out			Engine No.

r the Completion of Boiler Work Are Indicated

repairs come into the shop unexpectedly or unavoidable delays in the repair of parts occur, three or four locomotives on the regular schedule of the preceding month have to be carried over for completion on the revised current schedule.

The mechanical department as a rule provides for 30 to 35 light and general repairs a month, about 12 to 15 of which are firebox repairs, so that the foremen know approximately what will be required of them each month.

In order to promote production within the departments, a system of power trucking is employed by the routing department which keeps parts supplied wherever required without unnecessary delay.

Work of the Boiler Department

Boiler work is carried out whenever possible in the back shop. When heavy firebox repairs are necessary the boiler is brought into the boiler shop. As previously noted, the force in the boiler shop is also required to take care of a great many of the running repairs in the roundhouse. About 160 men are included in the staff of the boiler shop.

A portion of the shop is devoted to sheet metal and tank work. The shop equipment is quite complete and arranged in a series of small departments, feeding the work on the assembly floor. The flue department is a unit by itself, while the layout department and the machine tool section are located so that there is no interference between them.

Firebox Repair Methods

It is the practice to carry out all but complete firebox repairs when an entire rear end is necessary with the boiler on the frame. Three or four sheet jobs are taken care of in the shop with the boilers still mounted. Half side sheets and lesser work can generally be handled in the back shop.

For half side sheet repairs, for example, the staybolts are burned out, the sheet cut and dropped. The new sheet is laid out from the old one which is used as a template. When the new sheet is ready and laid out with the edges to be welded double v'd it is bolted up and welded inside and

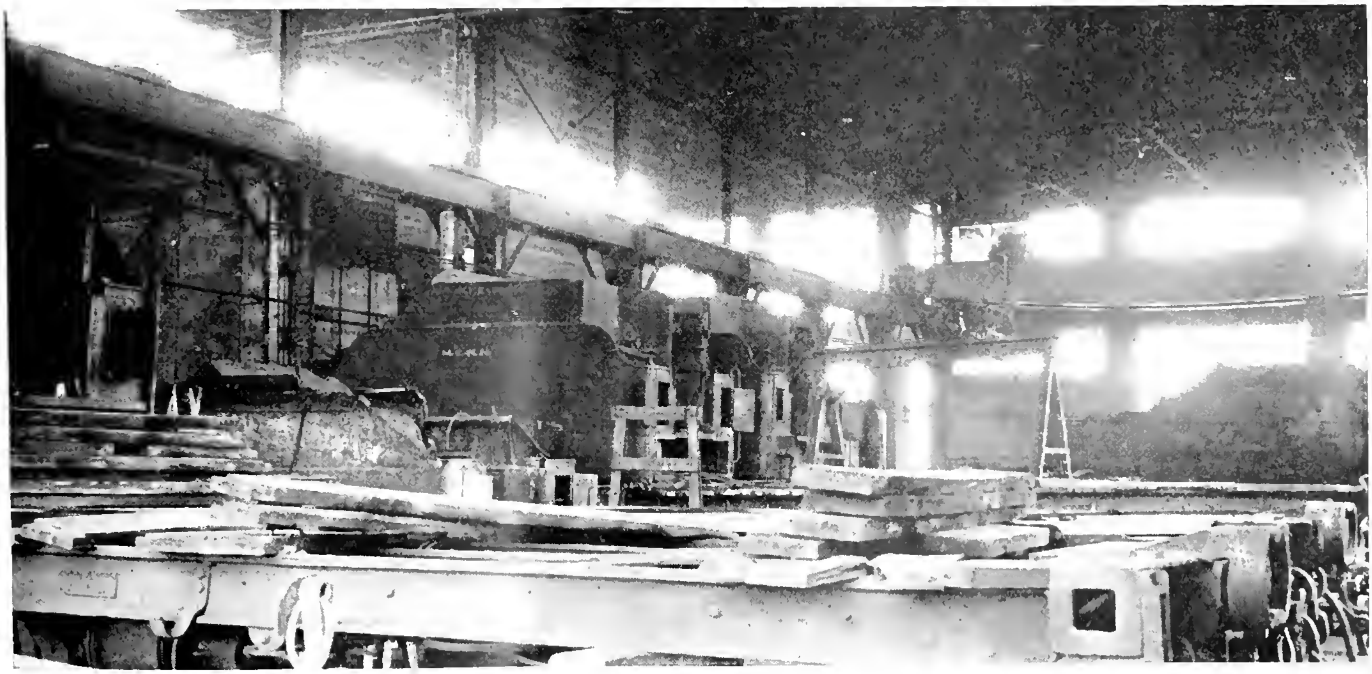
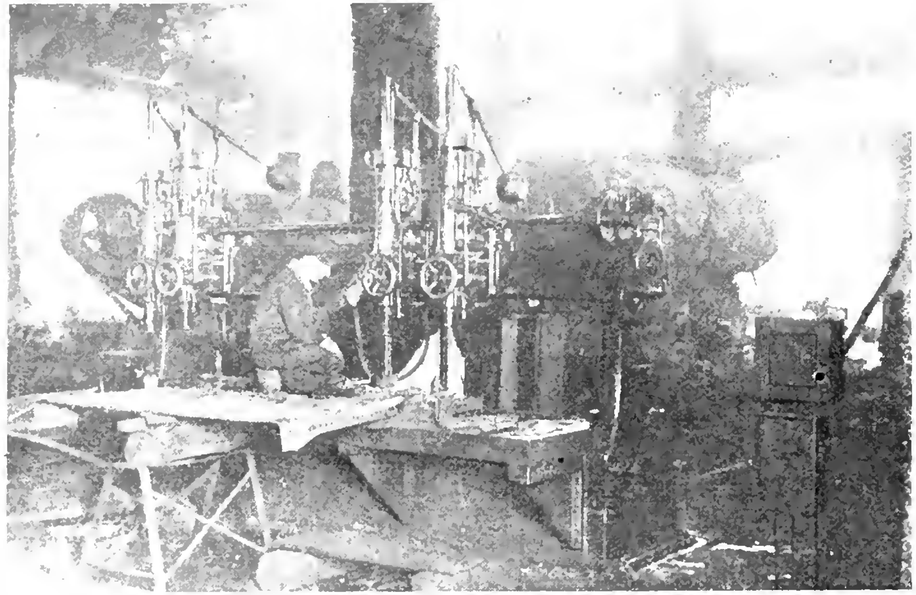
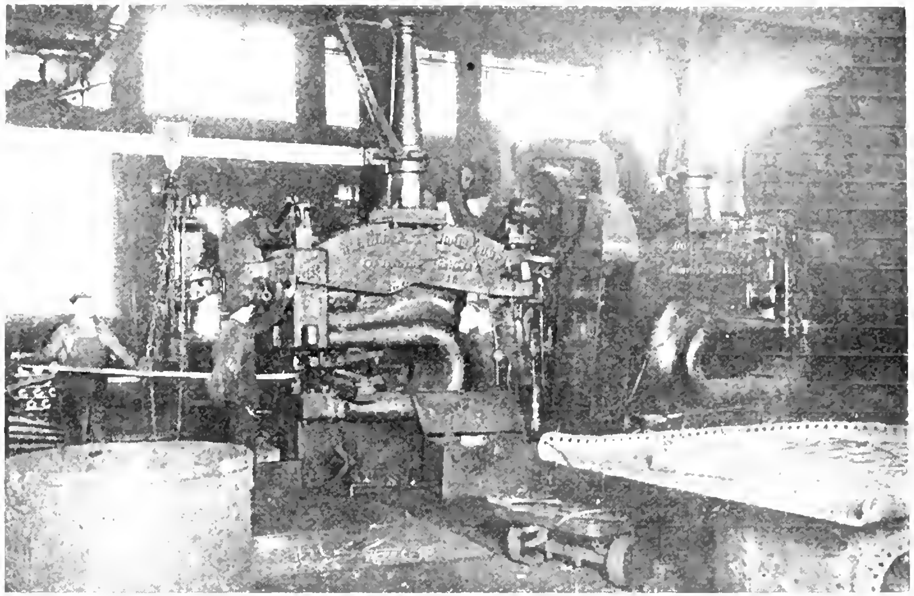
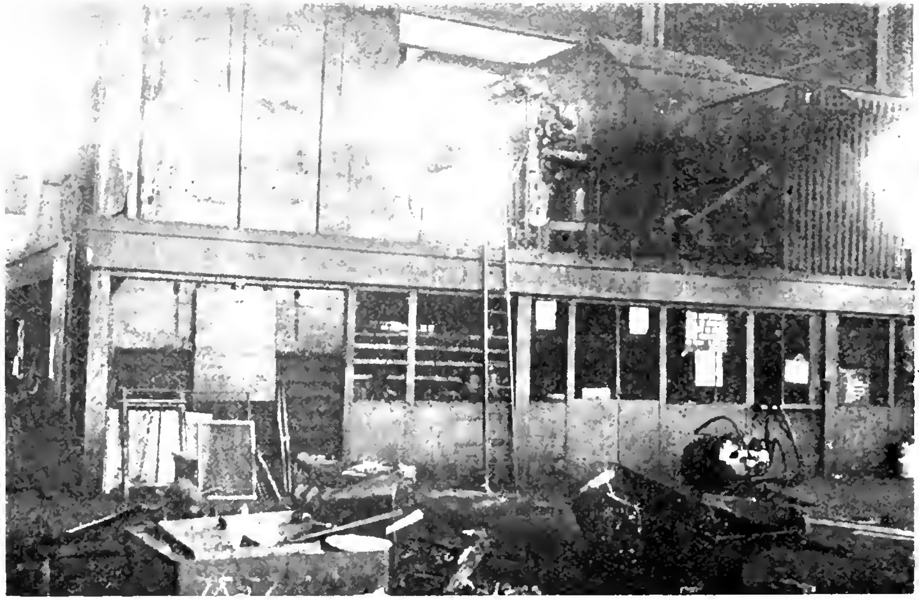


Fig. 4.—The Tank Department Is Also Located in the Boiler Shop







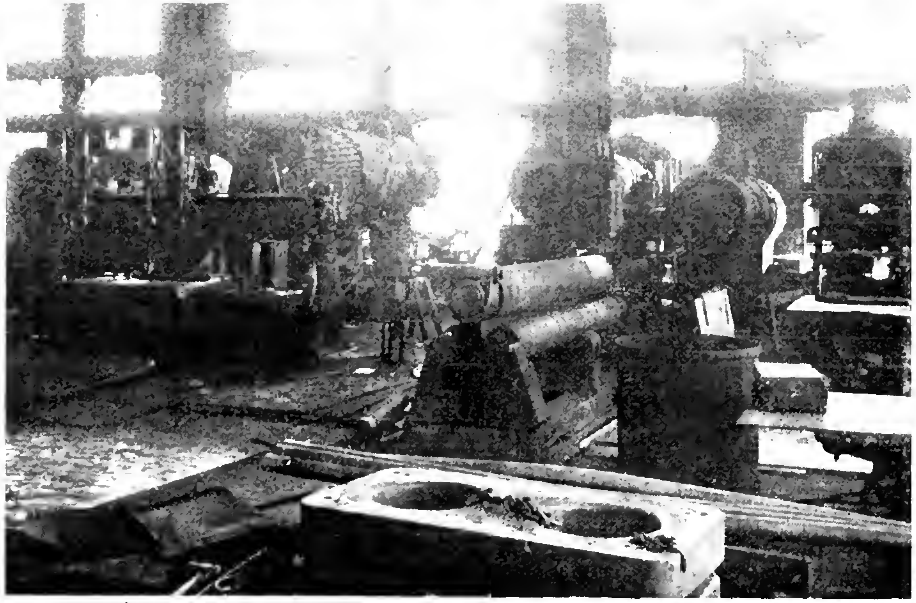


Fig. 4.—This 4 Spindle Gang Drill Saves Times in Sheet Drilling Operations. Fig. 5.—Powerful Punch and Shear Used in Sheet Fabrication. Fig. 6.—Combined Tool and Stock Room Is Conveniently Located. Fig. 7.—Heavy Machine Section Adjacent to Assembly Floor

out wherever the parts are accessible. When the back head is renewed it is laid out from the old sheet, flanged, bolted in place and the flange holes marked out. The door hole in each case is butt welded. When a new firebox is fitted, the boiler is taken down from the frame, turned over and the firebox dropped into place.

A McCabe machine for cold flanging is installed and this takes care of practically all flange work except throat sheets. With the 11/16-inch and ¾-inch sheets used in the throat it is necessary to do the flanging by hand.

Flue sheets are laid out from templates kept in stock for each class of engine coming into the shop. Holes are punched small and drilled out to size in the flat. Wherever possible, the work is laid out on the bench in the flat before flanging with the exception of the flange rivet holes which are drilled in position.

The edges of flanges are scarphed with the oxy-acetylene torch with a great degree of success. After the cutting operation the flange is chipped clean, the finished work having almost the appearance of machine scarphing.

Lack of Uniformity in Boilers

In all this work it is found that there is a lack of uniformity in boilers of a given class that come in for repairs.

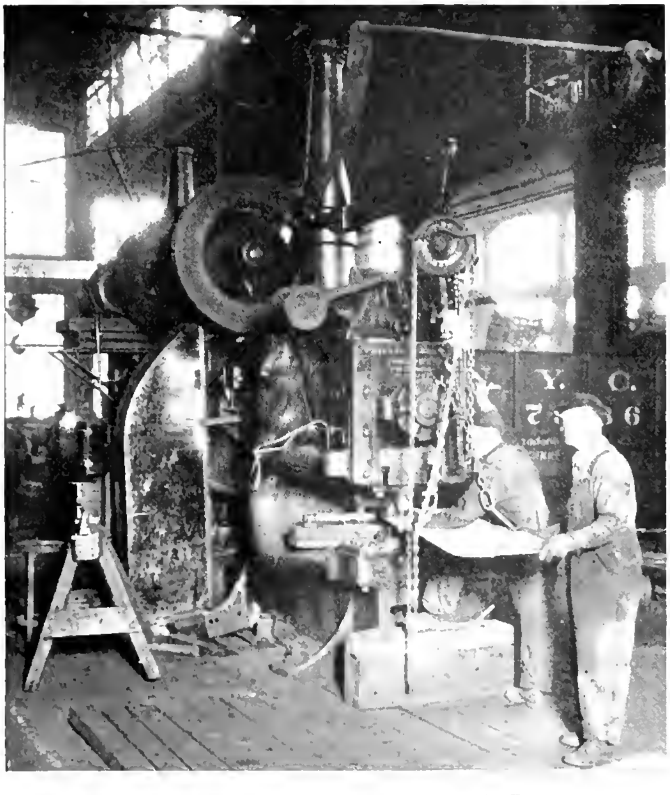


Fig. 8.—Working on Sheets for the Tank Department

Even boilers made by the same builder vary somewhat. The discrepancies become apparent when the blue prints supplied with the locomotives when new are used to lay out sheets or heads. No doubt service conditions where the sheets are exposed to heat and weaving action on the road are responsible for the distortion and pulling out of shape. In any event better results are obtained in practically every case by using the discarded parts for fitting up new ones.

Reconditioned Flues

Small tubes are safe ended satisfactorily four or five times while superheater flues are safe ended twice only before they are reclaimed. Mandrels in connection with the welding hammers will take care of safe ends up to 34 inches in length. In the reclaiming process sections of tubes up to 8 feet or 9 feet in length are welded on.

Practically all tube work for the Detroit shops and other Michigan Central shops in this section is done at Jackson so that it is necessary to keep two shifts running in the flue department at all times.

Two dry rattlers are installed at one end of the plant, each of which will take a charge of 275 small tubes and 40 to 50 superheater flues. Depending on the condition of the tubes and the water section from which they came the time for cleaning varies from 4 to 6 hours.

The safe end department has a capacity of about 120 small tubes an hour. The first part of the process consists in heating the flue, cutting and expanding it on a combination hot saw and expanding machine. After the end is trimmed it is belled on a tapered mandrel so that it will receive the safe end easily. The safe end is inserted on a pneumatic machine. The tube and safe end are then brought to a welding heat and inserted over the mandrel in the welding hammer. The welding hammer is of the half round type which has been found most satisfactory for insuring tight welds. The welded surfaces are finished on a fully round hammer after which they are cut to length. Each tube is tested under an air pressure of 130 pounds. In this test the regular shop air pressure of 110 pounds is used in conjunction with a booster which raises it to 130 pounds.

The tubes are installed with a sectional expander at the rear end while a special tool is used at the front end for expanding, at the same time. With this "double gunning" operation, it is unnecessary to hold on at the front end of the tube while the rear end is being worked. This procedure it can readily be understood saves considerable time in installing a set of tubes.

It is the practice to electric weld the superheater flues and the 2-inch intermediate tubes. Two and a quarter-inch tubes and 2-inch tubes below the bank of superheater flues are not welded, however.

Cutting Records Made at Jackson

In the Jackson shops the cutting and welding operations incident to repair work are in charge of a welding foreman and a staff of exceptionally well trained operators. In fact oxy-acetylene cutting records have been established here by one of the operators that, as far as can be learned, have not been equaled in any shop in the country. An outline of these records will be of interest as a check against the work of the cutting departments in other shops.

Engine 7950 was brought into the shop for new side sheets and, as conditions seemed favorable for testing the speed of the operator who handles most of the boiler cutting work, a time record was kept for each of the dismantling operations. The total time taken for the work was 15 hours and 10 minutes and in this period 1,038 staybolts and 392 rivets were cut out and 24 feet of side sheet cutting completed.

On flange scarphing operations with the torch, this same operator completed a flue sheet flange and throat sheet in 1 hour and 10 minutes. The flue sheet flange alone without the throat sheet required 1 hour.

In cutting out superheater flues the operator burned off the beads of forty-three 5⅜-inch flues in 55 minutes.

At another time the front end netting, plates and petticoat pipe were removed in 45 minutes ready for flue removal.

One hour and a half was sufficient time to remove the sheet iron pan on a class G-6 freight engine. The cast iron pan on a K-3 passenger locomotive was removed in 1 hour.

In checking up the speed for cutting out staybolts the operator required only 1 hour and 6 minutes for 253 rigid staybolts in a G-6 freight engine. On another job 994 staybolts were cut in 2 hours and 10 minutes.

Incidentally the operator who set up these records is only 19 years of age. His training and experience were gained in the Jackson shops.

At a later time The Boiler Maker will publish further details of the welding and cutting work at Jackson.

Trestles That Have Been Found Useful in Boiler Shops

Steel and Wood Trestles Made from Materials in the Shop to Meet Every Emergency—Kinks That Are Time Savers

By James F. Hobart

A GOOD trestle is a time-saver in any boiler shop and those concerns in which frequent use is made of boxes, barrels and cob-house timbering for supporting boiler and tank work may well afford to make up some steel trestles and save, by so doing, many hours now devoted to procuring and using wooden blocking.

Many a layout man would be glad of two or four rugged layout trestles as shown by Fig. 1, a trestle which will neither collapse nor tip over under any load likely to be placed upon it. This trestle is easily made up from material found in almost any boiler shop. The backbone A is a piece of stout structural T-steel. The feet or legs B and C may be fabricated from almost any half-inch plate, from tank steel to firebox stock, as may be available. The braces *D* and *E* are pieces of angle structural steel and are fastened by rivets to the backbone and to the legs of the trestle. The slots in legs *B* and *C* may be made either by drilling, or punching and chipping, or by cutting with oxy-acetylene.

The writer saw this fine trestle in the Beech Grove shop of the "Big Four" railroad at Indianapolis, Ind., and the men in that shop did not seem at all particular as to the weight of boiler plate which they placed on a couple of these rugged trestles.

Another Non-Tip Trestle

The trestle shown in Fig. 2 is almost as rugged as the one illustrated in Fig. 1. Originally made for use in boiler and machine shops, this heavy implement had been pre-empted by the wood working shop of the New Orleans and Lower Coast Railroad, and, when the writer saw it, was covered by a huge six-inch plank.

The backbone and legs of this trestle, as shown in Fig. 2, are made of heavy structural steel angles, six and four inches respectively. The legs sprawl out 45 degrees each, and from this the device takes its name, the pair of legs standing at 90 degrees, or "square" with each other. This construction makes it practically impossible to upset the trestle by sliding heavy steel or timber over it. The trestle is still further braced, endwise, by means of the sway-stays *C*, riveted to through-stay *A*, which in turn is fast to the legs at either end as shown at *B*. Brace *C* is also riveted to cross-brace *D*, which is located inside of the angle legs.

This form of construction makes a very strong trestle, capable of sustaining any load ever likely to be placed upon it, and, owing to the form of the top or backbone, it is especially adapted to use with heavy timbers and planks which can be pushed over the heavy angle with no danger of the timber catching a corner thereof, or of tipping over the trestle.

Light Angle-Steel Trestle

A trestle of lighter construction also found in the New Orleans shop of the New Orleans and Lower Coast Railroad, has its angle steel backbone set upright as shown at *A* in Fig. 3. Both this angle and the legs *C*, *C* are riveted to a plate or clip *B*, which is made of pretty heavy steel. End-sway in this trestle is prevented by braces *E*, which are placed about the same as shown in Fig. 2, for the right angle trestle. The brace is fastened direct to clip *B*, also to through-stay *D*, which in turn is riveted to angle *F* on the lower portion of the legs. This trestle is of lighter construction, yet strong and durable, but of course it will not stand as much hard work and abuse as the trestle shown in Fig. 2.

Pipe Trestles

Three forms of all-pipe trestles found in the Beech Grove "Big Four" shops are shown in the following illustrations. One, a very light trestle, is quite portable and takes the place of the ordinary wooden "horse" as particularly affected by carpenters and machinists as well as boiler makers. It has, as shown in Fig. 4, a three-inch pipe *E*, for a backbone, with legs *F*, also through and cross braces made of inch-and-a-half pipe. The round pad *G*, one under each of the four legs, prevents the pipes from sinking into the dirt when the trestle chances to be used on the ground.

Each and every joint in this trestle has been fitted and welded by the oxy-acetylene process, therefore there is not a rivet or a screw connection to be found, and the trestle is one of the smoothest and neatest bits of construction the writer has ever seen, without exception, in any boiler shop—or anywhere else. While not designed for the heaviest kinds of hard work, this trestle, nevertheless, is mighty rugged and will stand up under a big load. The three-inch pipe used as a "back-bone" makes a handy place in which to keep a pinch bar or two, and the center-punch lives there, with a hammer handle thrust in, too, with the head protruding.

Roller Trestle for Boiler Tubes

Another pipe trestle, but of much lighter construction and not designed to carry loads of much weight, is illustrated in Fig. 5. This trestle is also to be found in the Beech Grove shops, and it is intended to be placed alongside of the tube repairing machinery, merely to support one end of a boiler tube, while the other end of the tube is in the fire, or in a welding machine.

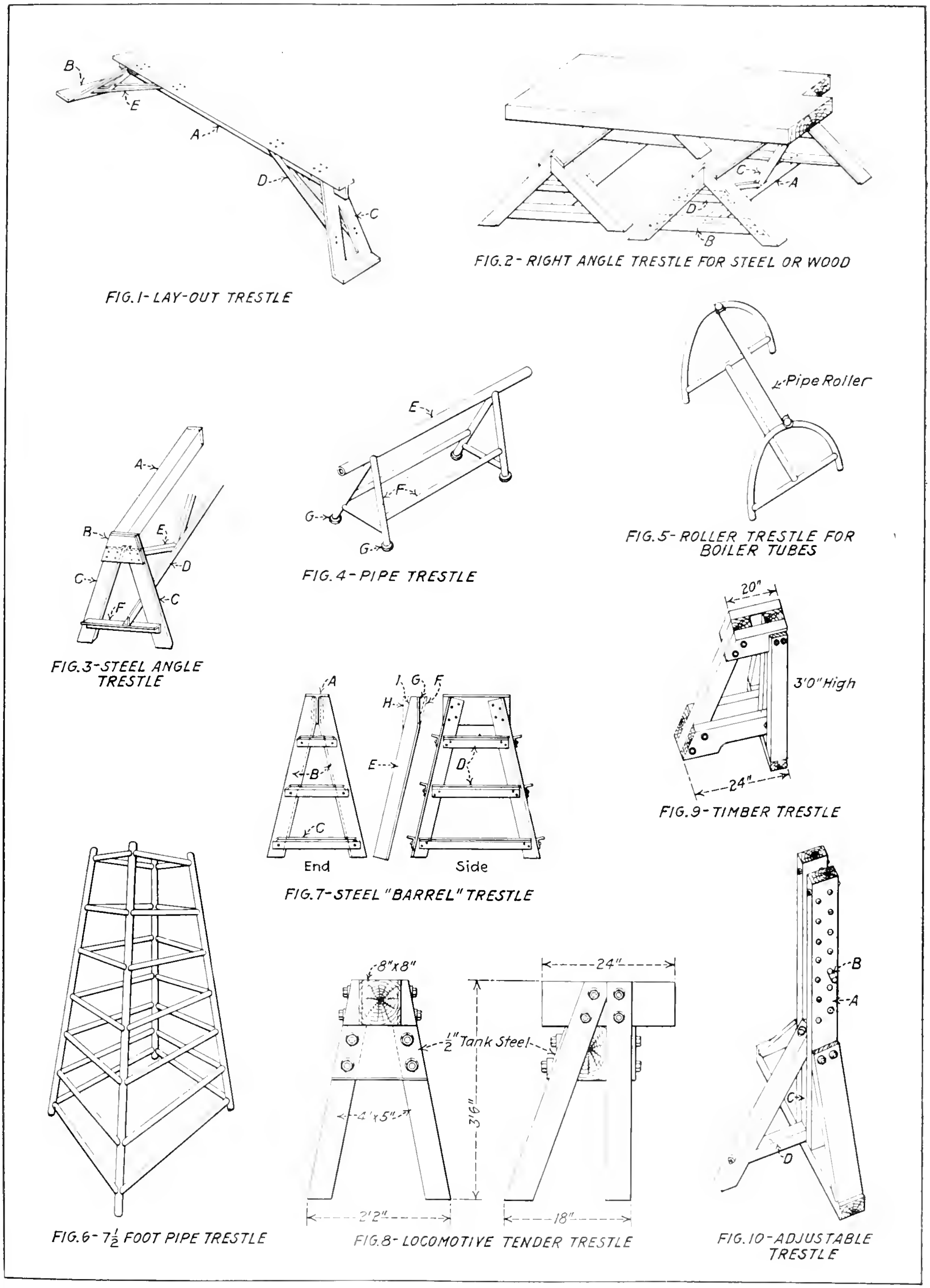
This trestle is also put together mostly by oxy-acetylene welding and is free also from rivets. It has the same clean and very neat appearance as is shown by the light pipe trestle described in a preceding paragraph. The backbone of this trestle consists of two pipes, one within the other, the inner and smaller pipe being welded to the ends of the trestle—they can hardly be called legs—the outer pipe serving as a loose roller over which the tubes pass when pushed into forge fire or welding machine.

Two screwed pipe connections are used in this trestle, one at either end of the pipe roller. The pipe upon which the roller revolves is screwed into a steel elbow at either end, with just sufficient end-play for the roller between them. The other end of each elbow is fitted on a grinding wheel to bear fair against the top side of the curved end-pipes of the trestle to which the elbows are welded fast.

A Welded-Pipe Ladder-Trestle

The very neat looking trestle shown in Fig. 6 is to be found in the Beech Grove shops. Alhough it was made in the boiler shop, I am sorry to have to admit that the boiler makers do not get much chance to use this type of trestle, which the car painting department prëempted and which they hang on to, like taxes and interest to a home-builder!

This trestle is about the height stated, and has seven



Types of Trestles Found in Use in Railroad Shops steps or rungs on each of its four sides. The top measures 20 by 36 inches and the bottom, 48 by 54 inches. It is made of two-inch black pipe, the ends of each rung being fitted to the corner members and then welded fast thereto by the oxy-acetylene process.

Wooden ladder trestles of this kind are to be found in most car paint shops, a single plank being placed on top or on any convenient rung, the painters ascending to the planks by the convenient rungs on the sides of the trestle. Although, as stated, wooden trestles of this kind are common, metal ones are not usually found although "A" shaped trestles made entirely of small structural steel angles are in use in the West Springfield shops of the Boston and Albany railroad.

For lightness and stiffness, to say nothing of its pleasing appearance, the pipe trestle shown above is far beyond any other similar form of trestle which the writer has as yet come across.

Steel "Barrel" Trestles

Out in the Morris Park (N. Y.) shops of the Long Island Railroad, they used to keep stout barrels for placing underneath the front end of a boiler when it was to be propped up somewhere near level. They also used barrels for supporting other things during boiler repair and assembly into locomotives. But, as one of the officials remarked to the writer: "When barrels were used, the hoops *would* get loose, the barrels get rickety and then they would *'squat'!*"

As a consequence, the very rugged little trestle illustrated in Fig. 7 was designed and it is needless perhaps to remark that never do these trestles "squat" under the heaviest load. The piece of T-steel *A*, which forms the top is twelve inches long. The bottom of the trestle is eighteen inches wide and twenty-four inches long. The height is the same as that of a barrel—thirty or thirty-two inches.

The legs *B*, *B* are of four-inch steel angle, the side rungs or braces are of lighter angle. Those on the ends *C* being placed on outside of the legs, while the side rungs *D* are placed between the flanges of the angles. The legs *B* were heated in a forge and bent, as shown by detail *E*, at *F* and *G*, until the web of the steel angle would lie flat against tee *A*. This action threw the side of the angle *I* into the position shown at *H*, but after the bending was completed the web at *H* was cut away until straight again as shown at *I*, thus permitting the leg flange to come flush with web of the *T*, as shown at *A*.

Wooden Trestles

Down in New Orleans, the "J. P. shops" are using stout wooden trestles under the front ends of locomotive tenders and elsewhere in boiler shop and tank work. One of these very rugged little trestles is shown in Fig. 8. Blocking is to be placed on top as required. They raise the tender from the truck, slip two rails under, upon four trestles, jack up the rails, block under them on the trestles, then run the tender truck out from under and remove the jacks thus completing the operation.

The dimensions and manner of construction are so plainly shown by the sketches that little description is necessary. Each shop may arrange minor details to suit the material at hand and the work to be done.

Little "Jumbo" Trestle

Another little wooden trestle which may be used for tender work, also for a great variety of other work in a boiler shop and elsewhere, is shown in Fig. 9. This trestle is made so it can be placed snug against a wall, all the bracing being sidewise and in front.

The dimensions of this trestle are shown in the illustration and its construction is very plainly shown. Only the size of the various timbers need be fixed in order to construct these trestles in your own shop, and the dimensions in question may be determined by the material at hand and the work which is to be handled by the trestle.

Adjustable Side Trestle

Another timber trestle is shown in Fig. 10. By means of holes in the extended vertical members *A*, pin *B* may be inserted at any desired height to support a timber upon which a tender, a car-body, or some part of a locomotive boiler may require to be supported at a certain height.

The manner of construction is plainly shown, as is the excellence of the side bracing. It should be kept well in mind that the strength of this trestle depends largely upon the insertion of timber *C* between the two vertical timbers *A* and immediately above and resting upon timber *D*, to which, and to all the other timbers, *C* and *A* are most securely fastened.

United States Civil Service Examination for Boiler Inspector

THE United States Civil Service Commission announces the following open competitive examination for local and assistant inspector of boilers.

The examinations will be held throughout the country on July 25 and 26. They are to fill vacancies in the Steamboat-Inspection Service, at entrance salaries ranging from $2,100 to $2,950 a year, and in positions requiring similar qualifications. Appointees at an annual compensation of $2,500 a year or less may also be allowed the increase of $20 a month granted by Congress.

For the position of local inspector of boilers, applicants must have had at least three years' experience as chief engineer of ocean or inland steamers of American registry of over 100 gross tons, or as first assistant engineer of steamers of American registry of 600 gross tons or over.

For the position of local inspector of hulls, applicants must have had at least three years' experience, under United States license, as master of seagoing steam vessels or of inspected seagoing motor vessels of American registry of over 100 gross tons, or in lieu of this experience they must have had certain other specified training and experience.

Applicants for the positions of assistant inspector of boilers and assistant inspector of hulls, must have had the same qualifications as those required for local inspectors, except that the required term of service is two years.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil service examiners of the post office or custom house in any city of the country.

Training of Oxy-Acetylene Welders

THE American Welding Society has issued an outline of a course for the training of oxy-acetylene welders. This report was prepared by a committee and combines the experience of experts of the Federal Board of Vocational Education, the American Welding Society and the National Research Council. For the information of the person who is selecting candidates, the text includes a discussion of the qualifications which the candidates for training should possess.

For the information of the instructor, the text includes the fundamentals in gas welding, together with a detailed statement of content, classified under type welding jobs arranged in the order of difficulty. Copies may be secured from the American Welding Society, 29 West 39th street, New York.

Cost Accounting

Report Read at Annual Meeting of American Boiler Manufacturers' Association at Hot Springs, Va.

At the annual meeting of the association held in French Lick Springs in 1920 a report was presented and subsequently printed in pamphlet form which it was hoped would help those who wished to start some kind of cost accounting system in their own plant.

The following are some advantages to be derived from a cost system as pointed out by the fabricated production department of the Chamber of Commerce of the United States in their bulletin No. 22:

(1) Strengthens the position of the industry in dealing with governmental or regulatory bodies.
(2) Inspires confidence that selling prices are determined upon a fair and equitable basis.
(3) Solves disputed points of accounting within the industry authoritatively.
(4) Makes possible a more intelligent competition.
(5) Reveals lines within the industry which have been marketed on an unprofitable basis.
(6) Shows the danger line below which goods cannot be sold at a profit, thus serving as an insurer of profits.
(7) Acts as a common guide to the value, efficiency and waste of workers, machines, methods, operations and plants.
(8) Becomes a reliable guide and basis for estimating prospective business, thus acting as a forerunner for comprehensive production statistics.
(9) Furnishes current rates for comparing major cost items with standards which are pre-determined and thereby measuring and increasing operating efficiency.
(10) Establishes a standard code of accounting practice so that if your cost clerk or bookkeeper leaves you his successor will step into a system whose operation has been fully and completely formulated.

Every manufacturer should have in his plant an accounting system so that every month he will know how much money he has made or lost, as the case may be, and know why the results as shown by the monthly statement are as indicated.

The cost of a boiler, stack, flues, tank, etc., is made up of three principal items:

(1) Material constituting same.
(2) Labor directly expended to fabricate it.
(3) Overhead.

(1) The material constituting the finished product ought to be called "direct material" inasmuch as material will go directly into the product as plates, tubes, etc. This is different from "indirect material" such as coal which goes to make up the overhead. The material that is purchased as "direct material" usually can best be handled by putting it into stock whether or not it is purchased for stock or actually for a particular product.

After an order has been received a bill of material should be made out: that is, a complete list of all material that is required to fill the order or manufacture the product; then requisitions or orders should be made out for all this material which is to be taken from stock or, if it is not in stock, ordered and put into stock: then when the requisitions that have been made out from the bill of material are filled the stock clerk sends them to the cost clerk who enters them on the cost. In this way no material can go into making up a product that does not appear on the cost.

If, for example, the bill of material is made up and by error some items are left out, they cannot go into the boiler until a requisition has been made out; then the cost clerk charges them to the job. In the above way of handling "direct material" little chance of error occurs and it tends to make up accurate costs.

(2) Direct labor is the labor expended by the employees fabricating the article. There are a number of ways in which this is handled. One of the simplest, however, is to give each man a number. If he works say from 7 to 12 on job No. 2,000 he turns in his time card with his number on it and the nature of the work he performs. He gets another time card if he goes on to another job and turns his time in in a similar way; that is, he obtains from the time clerk or his foreman a new time card for every job he goes on to.

As to his rate, it is more simple to have an average rate in each department; that is, in the boiler shop, for example, there will be men whose wages vary say from 35 to 75 cents an hour and the average can be figured out at say 60 cents an hour; that is, every man's time is charged at 60 cents regardless of what he is actually paid. Careful check should be made to be sure that the time cards are properly issued and filled out. In this way the actual cost of labor on an article is obtained and what the different operations actually cost. So if the labor on a certain cost appears to be higher or lower than might be expected, it can readily be traced down and the reason for the discrepancy determined.

(3) Overhead is probably the most difficult part of the cost to have accurately and properly proportioned. Overhead should be made up of two principal divisions, namely: Shop overhead and administrative and selling overhead.

The reason why it should be divided is:

(1) According to the Federal laws, in making returns to the Government the work in process at the end of the year should appear as to its value based on material, labor and shop overhead. The same applies to material made up for stock; that is, not for firm orders. Shop overhead is made up of such items as:

Electric power.
Repairs to buildings.
Repairs to machinery.
Insurance.
Taxes on real estate and buildings.
Fuel.
Firm's time, etc.

A budget of this should be made up for the year; that is, an estimate as to what it should be. With past records this can be pretty accurately determined.

Suppose we take a hypothetical case and assume the shop overhead amounts to $48,000 a year and that the plant will run at a fair average rate of productive hours—say 80,000 productive hours a year; then the shop overhead would be 48,000 ÷ 80,000 to determine the overhead rate per hour divide the shop overhead (48,000) by the productive hours (80,000) which gives 60 cents. It is better to have this cost appear with an overhead rate at 60 cents an hour than say 100 percent as your shop rate may vary and your overhead not vary.

If it is found, say after the first three months, that 60 cents is not the proper rate to take care of the overhead, or is too much, for the next three months it could be changed but, after the cost system has been in operation for some time and with accurate records available it can be pretty accurately determined. Shop overhead should appear on the cost monthly, as the work progresses, based on the productive hours expended.

(Continued on page 214)

Layout of a Twisted Pipe

Method of Obtaining True Lengths, Correct Angle and Miter Line of Elbow

By George A. Jones

TWISTED pipe work is very often encountered in connection with blast furnace work. To obtain patterns for this work, proceed with the center lines for the plan.

First draw the circle about *O* as a center equal to the outside diameter of the vertical pipe. Locate the centerline *X-R-X*^{x} in the proper location and locate the centerline of the upright pipe *X-P*^{x}.

Elevation

Above the plan erect centerlines for the elevation. First erect the vertical line from *R*, the point where the center line of the branch intersects the vertical cylinder and locate *T*. Then erect the vertical line through the center of the elbow *X* and locate *E*^{1} and *E*. Now erect the vertical line *P*^{x} — *L* and draw the center lines *T-E* and *E-L*. After the center lines are located draw the outlines of both pipes in the plan and elevation.

So far the pipe No. 1 is not shown in its true length or the angle of the elbow in its true angle, so more views will be necessary.

To lay out Fig. 5, at right angles to the center line *X-R-X*^{x} of the plan erect the line *X-A-B*, then line *R-G** and line *X*^{x}*4*. At right angles to line *R-G* draw line *G-B* and make the distance *B-A* equal to the vertical height *E-E* of the elevation. Now draw the center line *A-G-4*, Fig. 5. The distance *A-G* is the true length between these two points.

Outlines of the Pipe

Next draw the outlines of the pipe. Any place on the center line *A-G-4* about the point *S* draw the semi-circle and the line *1-S-7* at right angles to the center line. Divide the semi-circle into six equal spaces and number from *1* to *7*. Draw lines through these points *1* to *7* and parallel to the center line *A-G-4* of indefinite length towards *4*. Now draw the semi-circle about point *X*^{x} of the plan and space 6 equal spaces. Through these points draw lines parallel to the center line *X-R-X*^{x} to the large circle, *O*, and locate the points *2* and *6*, *5* and *3*, *6*^{x} and *2*^{x}, *5*^{x} and *3*^{x} and *4*^{x}. Lines dropped from these points at right angles to *X-R-X*^{x} to similar points in Fig. 5 will locate proper points on which to lay out the pattern for the branch end.

NOTE: When looking at Fig. 5, points on the near side are numbered *1* to *7* and on the far side *2*^{x}, *3*^{x}, *4*^{x}, *5*^{x}, *6*^{x}.

This completes Fig. 5. Now in the elevation extend the center line *E-L* on the bottom and at right angles to *L-E* and through *T* locate point *K*. Extend the center line *L-E* on top and locate *F*^{1} and draw the circle about *F*^{1}. Now return to the plan, extend the center line *X-P*^{x} and locate point *P*.

NOTE: The end of the pipe *P* is shown by a straight line. This should be an ellipse but, as no measurements are taken from this view, it is not necessary to draw the ellipse.

Correct End View

Now draw the line *R-R*^{1} parallel with the center line *X-P*^{x}*-P* and line *P-R*^{1} at right angles to *P-X*. The distance *P-R*^{1} that the pipes are off center in the plan is transferred to the center line *E-L* of the elevation and *F-F*^{1} is located. Next draw line *F-H* at right angles to the center line. Now draw line *H-F*^{1}. As this is a correct end view, the line *F*^{1}*-H* shows the direction of the center line of pipe No. 1. As the direction is from *F*^{1}*-H*, where this line crosses the circle locates the back of the elbow as *7*, and the throat of the elbow as *1*. Space the circle *F*^{1} the same as circle *X*^{x} of the plan. Number the points on the near side *1* to *7* and those on the far side *2*^{x}, *3*^{x}, *4*^{x}, *5*^{x}, *6*^{x}.

In the plan make *R*^{1}*-S*^{1} equal *K-T* of the elevation and draw line *P-S*^{1}. This line represents the direction of pipe No. 1 in this view. Just as line *F*^{1}*-H* in the elevation where line *P-S*^{1} crosses the circle point No. *1* is the throat and point *7* the back of the elbow and center line *P-S*^{1} of the plan should equal center line *F*^{1}*-H* of the elevation.

Correct View of Miter Line

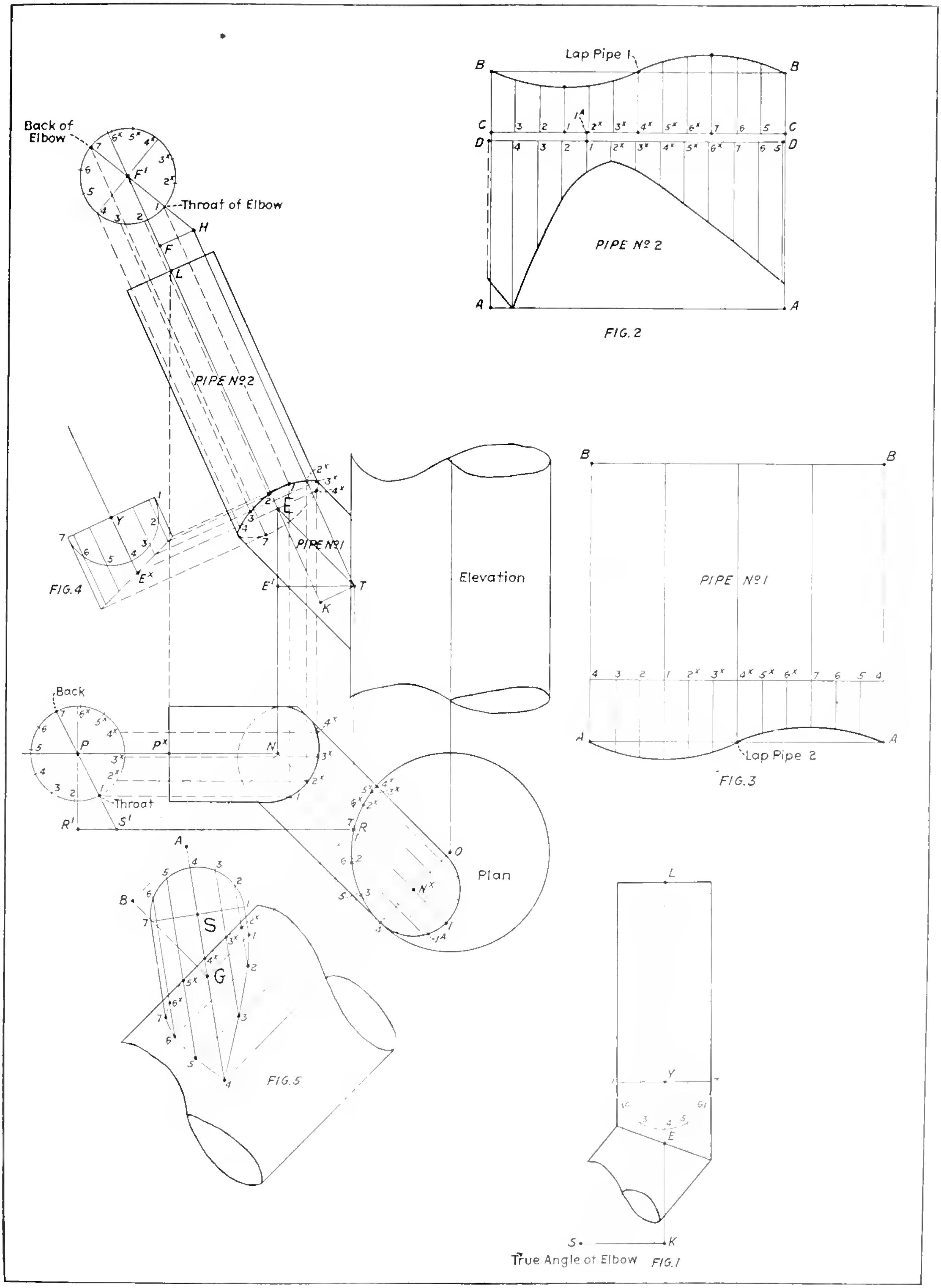
As the center line *E-T* of the elevation and *X-R* of the plan are foreshortened and not shown in their true length, it is necessary to erect a correct view of the miter line of the elbow at *E* of the elevation and *X* of the plan showing the miter line in a true position. To do so, first obtain a true angle of the elbow, as shown at Fig. 1. Erect the center line *L-K*, Fig. 1, equal to *L-K* of the elevation. Make *L-E*, Fig. 1, equal *L-E* of the elevation, which is shown in its true length. Now draw *K-S*, Fig. 1, at right angles to *L-K* and make *K-S* equal *F*^{1}*-H* of the elevation or *P-S*^{1} of the plan and draw the line *E-S*. Now the angle *L-E-S* is a correct angle of the elbow and these are the true lengths. *E-S* should equal *A-G*, Fig. 5, also, which is also the correct length.

On the line *L-E*, Fig. 1, at *Y* draw a semi-circle, space this the same as circle *S* or *X*^{x} and draw lines to the miter line. Parallel with the center line *L-E* of the elevation draw the line *Y-E*^{x}, Fig. 4. Transfer the section at Fig. 1 to Fig. 4, as shown, the line *E-E*^{x} being at right angles to *L-E*. Lines drawn over from the miter line in Fig. 4 to *E* of the elevation parallel with *E-E*^{x} intersecting similar numbered lines drawn from the circle *F*^{1} and parallel with the center line *L-E* will locate the points around *E* showing a true view of the miter line of the elbow and numbered *7*, *4*, *3*, *2*, *1*, *2*^{x}, *3*^{x}, *4*^{x}. All lines have not been drawn in order not to confuse the reader but it will be easily understood. The section of the miter line on the near side is drawn with a full line and on the far side with a dotted line.

Elbow Miter Line in the Plan

As pipe No. 1 of the elevation is foreshortened, we must locate the elbow miter line in the plan. To do so, space the circle *P* of the plan the same number of spaces as circle *F*^{1} of the elevation. Number the points on the near side *1* to *7* and those on the far side *2*^{x} to *6*^{x}. Through these points and parallel with the center line *P-P*^{x}*-X* run lines to *X* and drop vertical lines down from *E* of the elevation to similar numbered lines at *X*. Where they meet draw the ellipse as shown. This is a correct view of the miter line of the elbow. All lines have not been drawn but enough to show the method and marked *1*, *2*^{x}, *3*^{x}, *4*^{x}.

As the plan or outline shown about *X-R-X*^{x} is a correct end view for Fig. 5, and as point *1* on the ellipse at *X* is the correct location of the throat of the elbow, run line through *1* and parallel with center line *X-R-X*^{x} to the semi-circle *X*^{x} and locate point *1*^{a} on this circle. The distance measured from *1* to *1*^{a} on the circle is the twist that the point *1* for the elbow layout is set to the left of point *1* for the branch layout. Readers will notice that drawing all the



Details of Twisted Pipe Development

ellipse at E of the elevation and N of the plan is not necessary; as will be seen, only the point 1 or throat has been used. But it is necessary to understand the method of obtaining the ellipse in order to understand the work when just the point 1 is used.

PATTERNS

The pattern for pipe No. 1 is shown at Fig. 3. The lengths are obtained from Fig. 1. Turn over to roll. In Fig. 2, erect line A-A, the circumference, square up the plate and erect lines A-B equal to A-4 of Fig. 5 and draw line B-B from B on line B-A. Locate point C equal to E-Y, Fig. 1, and draw line C-C. Space this line and develop this end for the elbow exactly the same as regular elbow work.

Make the distance A-D, Fig. 2, equal S-4, the long point of the branch, Fig. 5, and draw the line D-D. With the distance 1 to 1^a on the semi-circle N^x of the plan transfer it to the right of point 1 on line C-C of Fig. 2, and locate point 1^a for the branch; drop this to line D-D. Space off equal spaces both sides of point 1. On line D-D erect lines as shown and obtain the lengths for these same lines from Fig. 5.

The curve drawn through these points completes the layout. Allow for laps and flange and turn over to roll. The dotted portion on the left of the pattern is cut off. The hole in the cylinder is obtained from the branch and Fig. 5.

Papers and Reports Read at 1923 Convention of Master Boiler Makers

SPACE did not permit the publication in the June issue of THE BOILER MAKER of all the papers and reports read at the Master Boiler Makers' convention held at Hotel Tuller, Detroit, May 23 to 26, so those that were omitted at that time are given below.

Review of Locomotive Accidents During the Year

By J. A. Shirley*

AS you know, the purpose of the locomotive inspection law is to promote the safety of employes and travelers by compelling common carriers engaged in interstate commerce to equip their locomotives with safe and suitable boilers and appurtenances thereto.

The law was amended March 4, 1915, to include the entire locomotive and tender. Since the law was enacted and the rules and regulations promulgated thereunder, which became effective July 1, 1911, there have been reported to the Interstate Commerce Commission up to March 31 of this year 8,259 accidents resulting in the death of 582 persons and the serious injury of 9,324 others, due to the failure of some part or appurtenance of the locomotive or tender.

Compare the number of accidents, number killed, and number injured, as a result of the failure of some part or appurtenance of the locomotive boiler to which the original act applied only.

	Year ended June 30				First nine months of fiscal year ended June 30	
	1912	1915	1921	1922	1922	1923
Number of accidents	826	424	342	273	214	398
Number killed	91	13	51	25	20	37
Number injured	1,005	467	379	318	253	471

You will note that accidents increased 86 percent, killed 85 percent, and injured 86 percent, during the first nine months of our fiscal year 1923, which began July 1, 1922, as compared with a like period during the fiscal year ended June 30, 1922.

It is to be regretted that some carriers appear to consider a congestion of traffic or an unfavorable condition a legitimate excuse for operating locomotives that are known to be in an improper condition for service and in violation of the law until the locomotives are found and ordered from service by our inspectors. The responsibility for operating locomotives in violation of the law rests upon the carriers, yet we have been compelled to bring court proceedings against a number of the carriers for infliction of the penalty provided by law, in order to bring about a compliance therewith.

Investigation of accidents where the fusion or autogenous welding process was involved supports our position previously taken that the process has not yet reached a state of perfection where it can be safely depended upon in boiler construction and repair, where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown sheet seams where overheating and failure are liable to occur, nor its excessive use in repairing long and numerous cracks in side sheets.

Our records show that approximately 77 percent of all autogenously welded seams involved in so-called crown sheet failures have failed, while 15.9 percent of riveted seams have failed under like conditions. The fatalities where sheets tore have been seven and one-half times as great as where they did not tear.

From July 1, 1906, to March 31, 1923, autogenously welded seams were involved in 24.3 percent of the crown sheet failures, while 46.5 percent of the total killed in crown sheet accidents were killed where the autogenously welded seams were involved.

The autogenous welding process is practically in its infancy and due to our desire to avoid hindering progress or the development of any process of such great value when properly and discreetly used we have hesitated to ask the Interstate Commerce Commission to establish or approve rules or regulations restricting its use in making repairs to the various parts and appurtenances of the locomotive and tender, including the boiler. However, unless it is confined to parts and appliances where through failure accidents and injuries will not result, we will be compelled to adopt some restrictive measures in the very near future.

During the first nine months of the fiscal year ended June 30, 1922, there were reported to this Bureau 39 accidents, resulting in serious injury to 39 persons, caused by failure of grate shakers. During the same period of the present fiscal year, 102 such accidents, resulting in serious injury to 102 persons, have been reported; an increase of 160 percent. The majority of these accidents were caused by the shaker bar not properly fitting the fulcrum lever.

This condition on many roads has been brought about because of no standard design being maintained making such parts interchangeable. All carriers should adopt a standard whereby shaker bars can be made interchangeable on all of their locomotives, with a proper fit.

* Mr. Shirley represented A. G. Pack, Chief Inspector of the Bureau of Locomotive Inspection.

The chance-taker is still with us. There has been a great increase in the number of accidents caused by attempting to tighten washout plugs while there is pressure in the boiler. No doubt some of the persons killed or injured in these accidents did not realize the danger to which they exposed themselves and others, but the foreman most assuredly did; he should see that employes are not exposed to needless danger from that source by absolutely prohibiting attempts to tighten washout plugs while the boiler is under pressure.

The Use of Automatic Stokers in Locomotives

THE effect of automatic stokers on firebox sheets is dependent upon the efficient operation of the stoker. If the stoker spreads the fuel over the entire grate surface evenly and the admission of air under the fire is such as to insure proper combustion, and the stoker is operated so that the opening of fire door is reduced to a minimum, the firebox sheets are benefited, and the checking and cracking of plates due to admission of cold air to the hot plates, is reduced.

The admission of enough air, properly distributed through the ashpan is essential to proper combustion, and has a great deal to do with the efficient operation of the stoker. If enough air is not admitted, or is admitted at the wrong point, it tends to make an uneven fire, and consequently an uneven heat on firebox sheets, which tends to check and crack them.

On a hand fired locomotive, the fireman is continually feeding fuel to the low spots on his fire, and if the air admission or draft is such as to burn his fire bright in spots he overcomes the tendency of an uneven fire by adding fuel to the places that need it. The stoker is designed to spread the fuel evenly over the grate surface and if combustion is poor in spots the stoker, if not watched closely, will aggravate this condition by a continued piling on of more fuel which is not consumed. Quality of fuel also enters largely into the efficient operation of the stoker.

From reports covering the hand fired vs. stoker fired locomotives, it has been noted that the temperature of the firebox dropped from 100 to 200 degrees when the fire door was opened for a sufficient time to apply fuel. In one case the pyrometer was put through a hole in the side sheet and registered the temperature of the air along the side of the firebox, but did not represent the temperature of the air directly above the fire door or on the crown sheet, which no doubt would be dropped to a greater degree.

When air at atmospheric temperature is admitted to the firebox, it must be heated to the igniting degree and if it enters in large volume through the firebox door, it makes it possible to flash through the firebox against the flues and side sheets before ignition temperature is reached, causing a contraction of the metal which is detrimental to both flues and firebox sheets, as well as combustion. We therefore feel that on the stoker fired engine efficiently operated, the fire door can be kept closed and that exclusion of cold air entering above the fire can be reduced, and the life of the firebox and flues lengthened on account of the air being properly heated as it rises through the fuel bed, creating better combustion and maintaining an even temperature throughout the firebox.

We have been unable to gather any authentic comparative data on the cracking of firebox sheets in stoker fired vs. hand fired locomotives. From reports from several roads where the stokers have been in use five years or more it is the consensus of opinion that the firebox sheets do not crack as readily on a stoker fired engine as on a hand fired engine. One road reports that with the same class of power in the same district no difference is noted. We would therefore refer this portion of the topic to the convention for discussion.

This report was prepared by a committee consisting of H. A. Bell, chairman; C. A. Nicholson and C. J. Baumann.

Efficiency of Combustion Chamber Boilers

OWING to the importance of the subject your committee sent inquiries to those members who have had the longest experience with the chamber.

The inquiries included: "General efficiency of chamber. Defects that were first to develop and remedies applied. Number of broken bolts per engine per month, and kind of bolt. Defects developing in the various parts of the chamber, and the life of the parts. Size or length of chamber. The diameter, length and number of tubes and flues. Whether equipped with brick arch or not. Hand fired or stoker? If chambers were not a success what was done to make them so?

We were much surprised and gratified with the prompt and full replies received, and the uniform desire shown to help the committee and Association as much as possible. We desire to thank these members for their assistance, and congratulate the Association on having these men as members.

There is a remarkable difference in the efficiency and life of the chamber on the various railroads using them. Some railroads are equipping old power with the chamber, others are removing the chamber and applying the straight box, also ordering new equipment with the straight box. There also is a great difference in the length of chambers: Those mentioned in our correspondence are 24, 29, 30, 36, 42 and 56 inch.

The majority of writers agree on the fact that the chamber is the cause of breaking many more staybolts than were broken in the straight box. Although most of this has been taken care of by the application of flexible bolts, one writer says: "We renewed as many as 35 to 40 staybolts per engine per month, and although we applied a full installation of flexible bolts, we still find many broken bolts."

Another member wrote: "Since applying a full installation of flexible bolts we have very little trouble with broken bolts."

Other defects that develop are cracks at rivet holes of circular seam and wings of throat sheet, the former sometimes extending into the base of flange.

Pits, grooves and cracks, occur along both top and bottom base of flue sheet flange and from base of flange to flue holes. These cracks often extend in both a vertical and horizontal direction, sometimes extending through bridges.

Cracks at arch tube holes. Cracks at front row of staybolt holes in bottom of chamber extending from 18 to 30 inches in length. Cracks at base of throat sheet wings.

Excessive pitting and grooving of wrapper sheet back of flue sheet seam and over front portion of crown.

And staybolt leakage in bottom of chamber.

To remedy the trouble with circular seams and wings flanges and wings of new throat sheets were extended and autogenously welded.

Defective flue sheets were renewed in some cases at the end of two years' service; in other cases at the end of three or four years. One member wrote: "Back flue sheets in our Pacific type engines with 72 inch shell and 36 inch combustion chamber last seven years. With straight standard firebox flue sheet gave four years' service." Two other members wrote: "Our combustion chambers are seven years old, but we have not renewed any flue sheets." The tendency to crack at arch tube holes was taken care of by one member by additional bracing when renewing throat sheet. The cracks at base of throat sheet wings were remedied by increasing the radius of the flange in new applications. The leakage of bolts in bottom of chamber was stopped by applying a layer of fire brick over the affected part.

A majority of the writers agreed that the tubes and flues were more efficient in the chamber type boiler, and their mileage was increased from 50 to 100 percent.

There is considerable difference in the number and length of tubes and flues in the combustion chamber boilers. The smallest has 158, 2-inch and 22, 5½-inch, length 16-feet 2 inches; the largest has 275 2¼-inch and 50, 5½-inch, length 21 feet 0-inches.

Basing our judgment on personal experience and on the experience of other members who have had a great deal of trouble with a large number of combustion chamber boilers we have concluded that, "The new combustion chamber boilers are not as easy to maintain as the straight standard firebox."

The chairman wishes to thank Mr. Ziegenbein for his very prompt and efficient assistance as a member of the committee.

Rules Governing the Care of Stationary Boilers

1. Safety Valves: Great care should be exercised to see that these valves are ample in size and in working order. Overloading or neglect frequently lead to the most disastrous results. Safety valves should be tried at least once every day to see that they will act freely.

2. Pressure Gage: The steam gage should stand at zero when pressure is off, and it should show the same pressure as the safety valves when that is blowing off; if not, then one is wrong, and the gage should be tested by one known to be correct.

3. Water Level: The first duty of an engineer before starting, or at the beginning of his watch, is to see that the water is at the proper height. Do not rely on glass gages, floats or water alarms, but try the gage cocks. If they do not agree with water gage, learn the cause and correct it. Water level in Babcock & Wilcox boilers should be at center of drum, which is usually at middle gage. It should not be carried above.

4. Gage Cocks and Water Gages: Must be kept clean. Water gage should be blown out frequently, and the glasses and passages to gage kept clean.

5. Feed Pump or Injector: These should be kept in perfect order, and be of ample size. No make of pump can be expected to be continuously reliable without regular and careful attention. It is always safe to have two means of feeding a boiler. Check valves and self-acting feed valves should be frequently examined and cleaned. Satisfy yourself frequently that the valve is acting when the feed pump is at work.

6. Low Water: In case of low water, immediately cover fire with ashes (wet if possible) or any earth that may be at hand. If nothing else is handy use fresh coal. Draw fire as soon as it can be done without increasing the heat. Neither turn on the feed, start or stop engine, nor lift safety valve until fires are out, and boiler cooled down.

7. Blisters and Cracks: These are liable to occur in the best plate iron. When first indication appears there must be no delay in having it carefully examined and properly cared for.

8. Fusible Plugs: When used, must be examined when boiler is cleaned, and carefully scraped clean on both the water and fire sides, or they are liable not to act.

9. Firing: Fire evenly and regularly, a little at a time. Moderate thick fires are most economical, but thin firing must be used where the draught is poor. Take care to keep grates evenly covered, and allow no air holes in fire. Do not "clean" fires oftener than necessary.

10. Cleaning: All heating surfaces must be kept clean outside and in, or there will be a serious waste of fuel. The frequency of cleaning will depend on the nature of fuel and water. As a rule, never allow over 1/16-inch scale or soot to collect on surfaces between cleanings. Handholes should be frequently removed and surfaces examined, particularly in case of a new boiler, until proper intervals have been established by experience.

The Babcock & Wilcox boiler is provided with extra facilities for cleaning. For inspection and washing, remove handholes at both ends of tubes, and by holding a lamp at one end and looking in at the other, the condition of the surface can be fully seen. Run the Rotary flue cleaner through the tube until it is clean and free from sediment. In replacing hand-hole caps, clean surfaces without scratching or bruising, smear with oil, and screw up tight. Examine mud-drum and remove sediment therefrom.

The exterior of tubes can be kept clean by the use of blowing pipe and hose through openings provided for that purpose, and must be given frequent attention. In using smoky fuel, it is best to occasionally brush the surfaces when steam is off.

11. Hot Feed-Water: Cold water should never be fed into any boiler when it can be avoided, but when necessary it should be caused to mix with the heated water before coming in contact with any portion of the boiler.

12. Foaming: When foaming occurs in a boiler, checking the outflow of steam will usually stop it. If caused by dirty water, blowing down and pumping up will generally cure it. In cases of violent foaming, check the draft and fires.

13. Air Leaks: Be sure that all openings for admission of air to boiler and flues, except through fire, are carefully stopped. This is frequently an unsuspected cause of serious waste.

14. Blowing Off: If feed water is muddy or salt, blow off a portion frequently, according to condition of water. Empty the boiler every week or two, and fill up afresh. When surface blow-off cocks are used, they should be often opened for a few minutes at a time. Make sure no water is escaping from the blow-off cock when it is supposed to be closed. Blow-off cocks and check valves should be examined every time the boiler is cleaned.

15. Leaks: When leaks are discovered, they should be repaired as soon as possible.

16. Blowing Off: Never empty the boiler while brickwork is hot.

17. Dampness: Take care that no water comes in contact with exterior of the boiler from any cause, as it tends to corrode and weaken the boiler. Beware of all dampness in seatings or coverings.

This report was prepared by a committee consisting of J. J. Davey, chairman; Charles Zeitz and George C. Nicol.

Topics for 1924 Convention

HEREWITH is a list of subjects recommended for the 1924 convention:

No. 1. Most economical method of cutting off and removing mudring rivets, and cost.

No. 2. The training and developing of apprentices.

No. 3. Does the application of thermic syphons increase the life of firebox sheets and flues?

No. 4. Most economical method of removing firebox sheets for renewal, describing method and cost. Is it more economical to renew firebox without removing boiler from the frame?

No. 5. Increased output per man hours.

No. 6. Shop kinks.

Additional topics will be published later.

The chairman of the Committee on Topics was John F. Raps.

Diameters and Heights of Stacks for Steam Boilers*

By E. C. Fisher†

The need for more rational, more practical formulæ for determining the size of chimneys for steam boilers has for some time been recognized. The real need, however, has recently been forcefully brought to the attention of boiler and stoker manufacturers because of the high ratings now being demanded. These high ratings are accompanied with high draft loss through the boilers, due to increased volume—hence velocity—of the gases, which in turn greatly increase friction. This loss has naturally rendered present chimney tables obsolete.

BECAUSE of the importance and general interest of this problem our President placed it before the joint committee of this Association and the Stoker Manufacturers' Association for solution if possible. The joint committee met and made a study of the problem. They realized that proportioning chimneys and breechings from grate area was illogical and that the rational method was to work from a gas basis where volume and the velocity are taken into consideration. There was considered in this study the paper of Mr. A. L. Menzin, entitled "Proportioning Chimneys on a Gas Basis," presented before the American Society of Mechanical Engineers at the annual meeting, December, 1915, and to be found in the Transactions, Vol. 23, page 1065. The committee recommends the reading and study of that paper because the theory here used is very clearly and simply set forth in that paper.

The paper entitled "Charts for Determining Stack Dimensions," by Mr. R. A. Foresman, chief engineer of the Stoker Department of the Westinghouse Electric and Manufacturing Company, printed in *Power*, November 21, 1922, was also given thorough consideration.

It was further ascertained that in addition to the work done by the Stoker Department of the Westinghouse Electric & Manufacturing Company, the Sanford Riley Stoker Company had also been giving careful study to this problem, same being largely in the hands of Mr. A. H. Blackburn and Mr. R. L. Beers. Mr. Beers is now chief engineer of the Detroit Stoker Company. Their work has been based upon the formulæ developed by Mr. Menzin in his paper above referred to.

After a careful comparison of the results obtained by Mr. Foresman, Mr. Blackburn and Mr. Beers, by plotting the two sets of results obtained side by side, a very slight variation in results was noted. The slight variations were easily accounted for by comparing the different assumptions used. It was, therefore, decided to adopt Mr. Foresman's curves for further work.

It is, of course, fully understood that there are many variables entering this problem, prominent among which are draft loss through the boiler, draft required to produce the required velocity up to the boiler damper, draft loss in the chimney itself; draft loss in the breeching, and effect of altitude. The weight of gases delivered to boiler and percentage of heat rejected to the chimney varies with varying percentages of CO_2 and different chimney temperatures. This variation may be one of very high degree.

It is apparent from the above that many assumptions must be made in the preparation of charts such as are to follow, and Mr. Foresman has, the committee feels, tried to keep on the safe side in making his assumptions. The method employed by Mr. Foresman for determining the data and plotting his curves is as follows:

Assumptions for Stack Calculations

It will be recognized that before the dimensions of a stack can be determined, it is necessary to make a number of assumptions on which to base the calculations. These assumptions are such that they vary quite widely and so rapidly that they do not remain constant on one piece of apparatus or with one fuel for any appreciable length of time. It is, therefore, necessary that the values of these quantities must be determined from actual experience on stoking apparatus, boilers and necessary auxiliary ducts, etc.

The assumptions made are relatively safe and are as follows:

(1) Efficiency—68 percent at 100 percent and 200 percent rating of the boilers.
(2) Efficiency—63 percent at 300 percent rating of the boilers.
(3) CO_2—9 percent in the stack at 100 percent rating.
(4) CO_2—10 percent in the stack at 200 percent rating.
(5) CO_2—11 percent in the stack at 300 percent rating.
(6) Stack temperature—450 degrees at 100 percent rating.
(7) Stack temperature—525 degrees F. at 200 percent rating.
(8) Stack temperature—600 degrees F. at 300 percent rating.
(9) Initial air temperature—60 degrees F.
(10) Barometric pressure—14.7 pounds per square inch.

Curves A and F

The calculation of the required data for these curves is quite simple and can be found in "Steam" page 156. The abscissæ are boiler heating surfaces and the ordinates are cubic feet of flue gas. This latter is not shown on the curve. The ratings were calculated from the assumptions shown above and are plotted as "rating curves."

Weight of coal for a given rating=

$$(1)\quad W_1 = \frac{PR\ 970.4\ (34.5)}{CE} = 33{,}478.8 \times \frac{PR}{CE}$$

where W_1 = weight of fuel, pounds.
P = horsepower rating of the boiler.
R = percent rated capacity.
C = B.T.U. of fuel as fired.
E = efficiency of boiler and stoker.

An average figure was determined for the combustible value of the fuel. This permits of employing the curves with any coal as no reference is made to its calorific value. The actual data are in the form of "pounds of flue gas per horsepower hour developed" due consideration being given to the varying weight of gas per pound of fuel burned, due to the varying CO_2.

The limits of error of such a procedure are within the limits of error of the assumptions made.

The weight of gas per minute to burn the above coal was determined by:

$$W_2 = \frac{3.036}{60}\ \frac{(\quad N\quad)}{(CO_2 + CO)}\ C\ W_1 + W_3$$

$$(2)\quad W_2 = .506\ C\ W_1\ \frac{(\quad N\quad)}{(CO_2 + CO)} - W_3$$

W_2 = weight of gas per minute to burn the required coal.
W = weight of combustibles burned.

*Report of sub-committee of the joint American Boiler Manufacturers' Association and Stoker Manufacturers' Association committee read at the thirty-fifth annual convention of the American Boiler Manufacturers' Association at The Homestead, Hot Springs, Va., June 5.

†The Wickes Boiler Company, Saginaw, Mich.

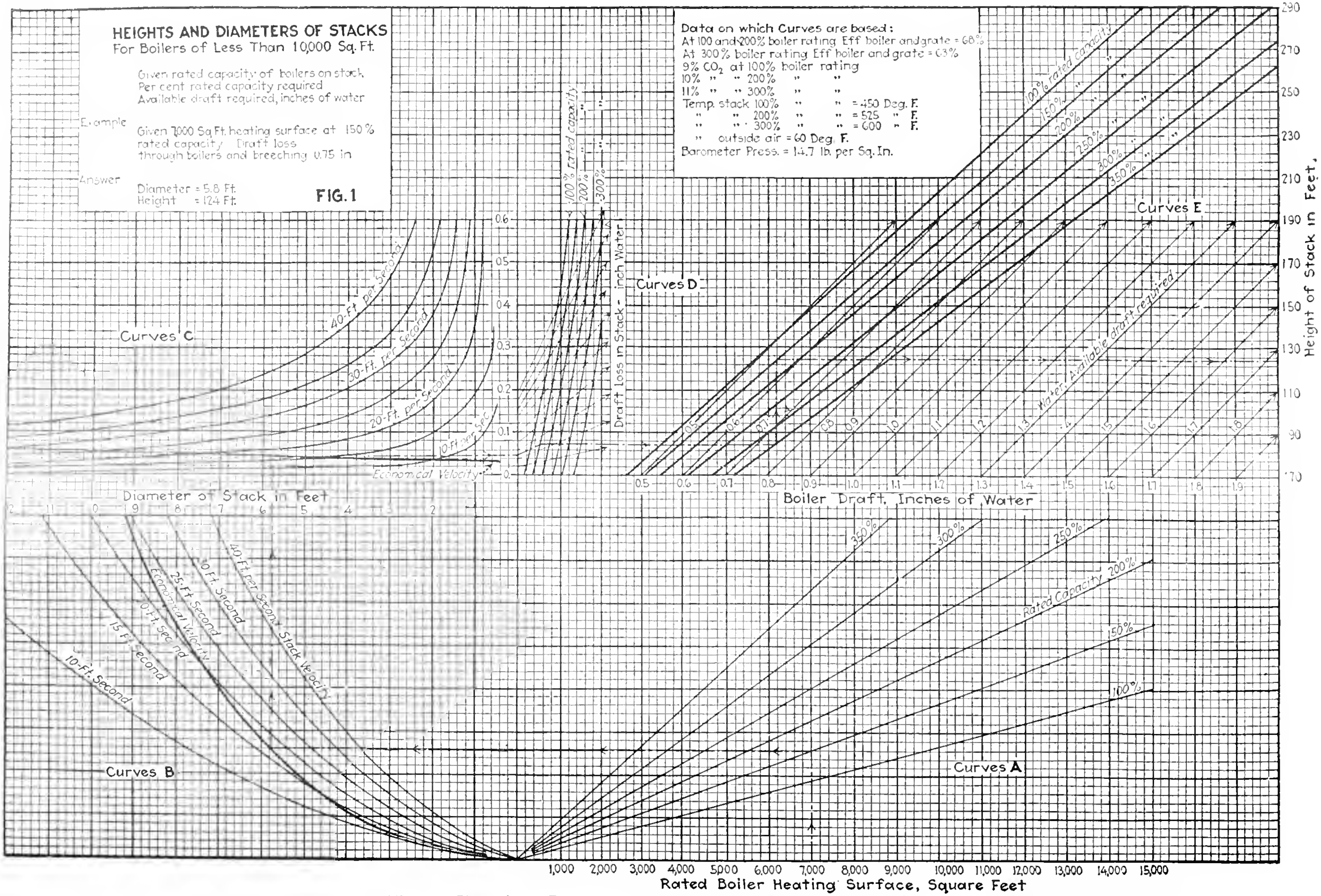


Fig. 1.—Chart from Paper "Proportioning Chimneys on a Gas Basis"

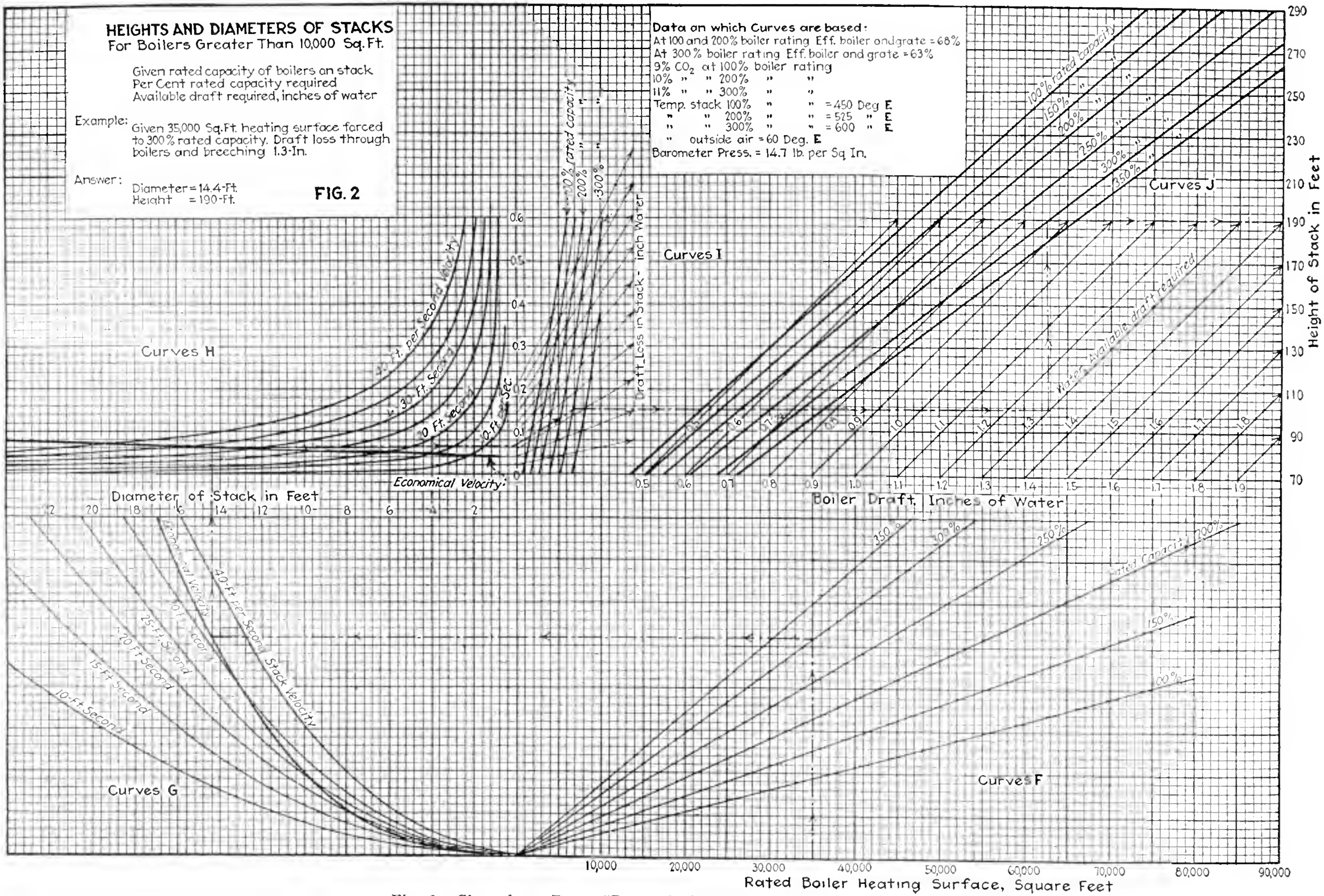


Fig. 2.—Chart from Paper "Proportioning Chimneys on a Gas Basis"

N = percent nitrogen (assumed to be 81 percent).
CO_2 = percent CO_2
CO = percent CO.
C = percent carbon burned.

To convert the weight of gas into cubic feet at the stack temperatures.

(3) $V_1 = W_2 (V_2)$

V_1 = cubic feet of flue gas given off at the stack temperatures.

V_2 = cubic feet per pound of flue gas.

Curves B and E

In these curves the same ordinates are used, namely: "cubic feet of flue gas," the temperatures of the gas being as shown above. The abscissæ are "diameters of stacks." It is assumed that all stacks are cylindrical.

With the volume (V_1) and the velocity given it is very easy to calculate the area or diameter required.

$$(4) \quad A = \frac{\pi D^2}{4}$$

A = cross sectional area of the stack at the top.
D = Diameter of the stack at the top.

$$(5) \quad S = \frac{V_1}{60A}$$

S = velocity of the gas up the stack.

The above calculation is made for a great number of cases and the velocity curves are plotted.

The economical velocity curve has been determined from constructional consideration. It is so proportioned that the stack may be quite easily built. The authority for these proportions can not be located but it is believed that it was taken from some article in *Mechanical Engineering*.

Curves C and H

These are velocity curves plotted with stack diameters as abscissæ and draft loss per 100 feet of height as ordinates. The authority for this is given in A.S.M.E. bulletin No. 1518, from which this curve was copied with the necessary modifications.

Curves D and I

The plotting of the remaining curves is quite complicated as there is no direct connection between the computation of stack diameters and stack heights. In order to accomplish this it was necessary to devise a transition curve as shown in curves D and I. The ordinates of these curves are "Total Internal Draft Losses in the Stacks," but for curves C and H these same ordinates are "Internal Draft Losses per 100 Foot Height."

The rating curves (D and I) are drawn to any given slope. This is immaterial as it is the intersection of these curves and the diagonal "Draft Loss in Stack" curves that is of value, and this intersection would fall at the required ordinate irrespective of the slope of the "rating curves."

The diagonal "Draft Loss in Stack" curves (D and I) have been determined by calculating an average height of stack for the various ratings and velocities; then determining therefrom the internal draft losses, and then plotting these points on the "rating curves" against the "Total Internal Stack Loss" as ordinates. These points then determine the slope of the "Draft Loss in Stack" curves and they can then be plotted. It will be noted that although the left hand ends of these diagonal lines represent the "Internal Loss per 100 Foot of Height," their intersection with the "rating curves," when referred to the ordinate gives the average "Total Internal Stack Loss" for the various ratings.

Curves E and J

Curves D and I ordinates are "Total Internal Draft Loss," and this quantity plus the "Available Draft Required" equals the "Total Draft."

It will be noted that this is taken care of by the direction of the "Available Draft Required" curves. It is available draft that is necessary to remove the gases, but stacks must be designed on the basis of total draft.

These "Rated Capacity Curves" (E and J) are determined as follows: Assume a given problem and follow the curves through as though the curves were complete except that the height must be calculated. Assume any "Available Draft." Follow a line through until the given "Available Draft" is reached then draw a vertical line from that intersection. By calculation the height is known and from that height draw a horizontal line and its intersection with the above vertical line gives a point on the "Rated Capacity Curves." This must be done for a great many ratings, and with varying conditions of draft. The points thus obtained determine the "Rated Capacity Curves" (E and J).

The "rating curves" E and J could also be plotted as temperature curves showing the total draft produced by a given height of stack at varying temperatures as it is assumed that definite temperatures are obtained at these ratings. Inasmuch as lower temperatures are obtained at the lower ratings, it is evident that for a given draft loss a higher stack will be necessary for the lower rating.

It will be noted that apparently a higher stack is required for low ratings than for high ratings. This is not true, of course, as the draft loss through boilers and breeching is so much less for low ratings than for high ratings. The low rating curves should be above the high rating curves as the internal temperature will be less in the former, and the amount of excess air will be somewhat greater. Both conditions being conducive to less draft and greater height.

At first glance the charts may seem to be rather complex, but by following a few cases through it will quickly be seen that the charts are very simple to use. They have been used by the Westinghouse Company for six months, have been checked against actual stack performance repeatedly, and in every case have worked out well. Mr. Foresman described the use of the curves as follows:

Chart No. 1 (Fig. 1) is for boilers of less than 10,000 square feet heating surface, while No. 2 (Fig. 2) is for the boilers of 10,000 and upward. Both charts contain notations of certain air and gas conditions that are assumed for basing these curves. It is necessary to know the amount of connected heating surface in square feet as well as the draft pressure required to carry the gases through the boilers and breechings. Any desired velocity of gases in the stacks may be used; the curves at B and C, Fig. 1, contain lines that represent the *economical stack velocity* as the average of commercial conditions indicates. The stack diameter, draft loss in stack and height of stack may be determined from curves C, D and E.

Example No. 1, as noted on Chart No. 1, assumes that the evaporating surface of the boilers on the stack is 7,000 square feet, the draft loss being 0.75 inch of water for boilers and breechings, working at 150 percent rated capacity. Find diameter and height at the economical velocity.

The chart indicates the line from curves A, starting at 7,000 square feet heating surface and rising vertically to the 150 percent rating line, moving horizontally from there to the curves at B, where the *economical velocity* is encountered. The stack diameter of 5.8 feet is here indicated. Moving vertically we come to the *same velocity* in curves C, which is the line of *economical velocity*, and then move horizontally to curves D. After touching curves D at the vertical starting line, then move parallel to the inclined direction lines shown with arrowheads until the 150 percent rating is encountered. From this point move horizontally to the curves E, where a draft loss of 0.75 inch is obtained, which comes midway between inclined lines 0.7 and 0.8 noted by arrowheads. From this point rise vertically to the 150 percent rating and read the stack height at the scale to the right, which in this case is 124 feet.

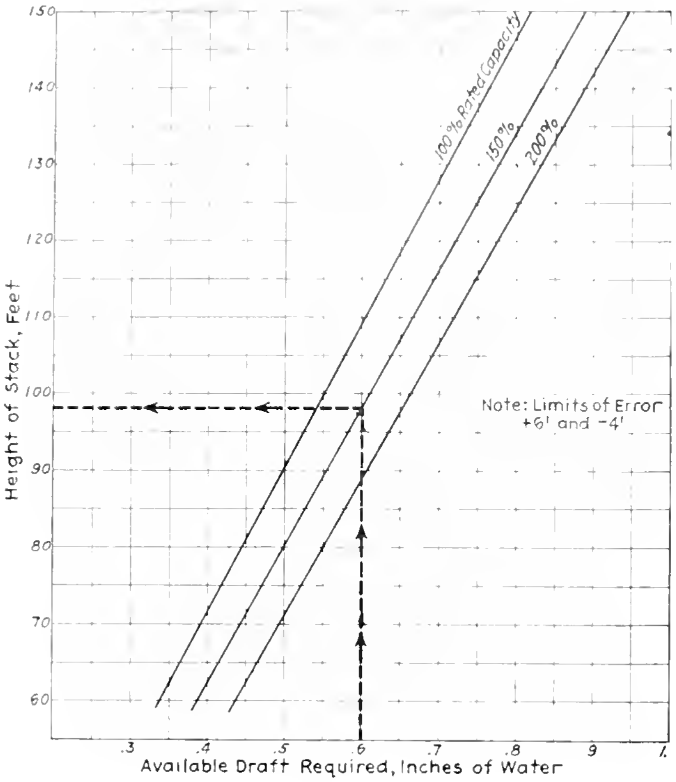


Fig. 3.

The draft caused by stack loss is shown at curves D. This is 0.045 inch of water. The total draft pressure required is the sum of this stack loss and 0.75 inch required for boiler breechings, which totals 0.795 inch.

Example No. 2. Suppose it is required to carry 175 percent rating on the same stack, how much would the stack height require to be increased, assuming that the draft pressure required for 175 percent rating is 1.05 inches of water? Rising vertically from 7,000 square feet to a point midway between the 150 percent and 200 percent rating lines, we then move horizontally to the stack diameter as in Example 1, which gives a velocity of 20 feet per second. We then rise vertically to the 20 feet per second line, curves C, and move horizontally to the curves D of stack loss, which amounts to 0.06 inch. Moving obliquely with the direction lines to 175 percent rating, and then horizontally to a draft-pressure requirement of 1.05 inches (1.05 — 0.06 = 0.99 on the diagonal lines) which is obtained from the oblique line in curves E, we then rise vertically to the line of 175 percent rating and obtain a stack height of 166 feet, read at the right. This would mean an increase in height of 166 minus 124, or 42 feet.

Example No. 3. Assume the same boilers and losses, at 150 percent rating, what stack height and diameter would be required for a velocity of 25 feet per second? The diameter taken from curve B is 4.8 feet. The stack loss in this case is 0.115 inch from curves D. The boiler draft requirement is 0.75 inch as outlined as a condition in Example No. 1. Using 150 percent rating, we find that a stack height of 146 feet is necessary.

Example No. 4. Suppose the same boilers were to be placed on a stack 6½ feet in diameter and 250 feet high and assuming that the loss of the boilers and breechings at various ratings varied as the square of the ratings, find the ratings to which the boiler may be forced. Taking a reading with 150 percent rating and 0.75 inch draft pressure required for boilers and breechings, we find that a 6½ foot stack gives 13.75 feet per second velocity, curves B, with a stack loss of 0.03 inch. The stack height is 116 feet. Now assuming a 200 percent rating and a loss of boiler and breechings of 1.4 inches, we obtain the *economical velocity*, which is 18 feet per second; the loss in the stack is 0.045 inch and the stack height is 228 feet. The stack would, therefore, be satisfactory for 200 percent rating.

In order, however, to make the matter even more simple the following tables have been prepared from the curves, so that anyone preferring to use tables in place of curves may do so, and, of course, obtain the same results.

The committee recommends that for horizontal breechings the sectional area should be 20 percent larger than that of the stack—this to allow for increased friction in a horizontal over a vertical column, as well as reduction of area by accumulation of dust on the bottom of the breeching.

The committee believes it has been the practice of the majority of return tubular boiler manufacturers to proportion stack areas to the aggregate area of tubes. It is quite general practice in determining the area of the stack to provide approximately 20 percent increase of area over the aggregate area of the tubes. From the curves (Figs. 3 to 6) it is apparent that the diameter of stacks determined in this way is sufficient for operating the boilers at 150 percent of their rated capacity. The height of stacks for return tubular boilers has ranged from 25 feet on smaller boilers, say 30 inches in diameter by 8 feet long, to 60 feet on boilers 72 inches in diameter by 18 feet long. These heights provide

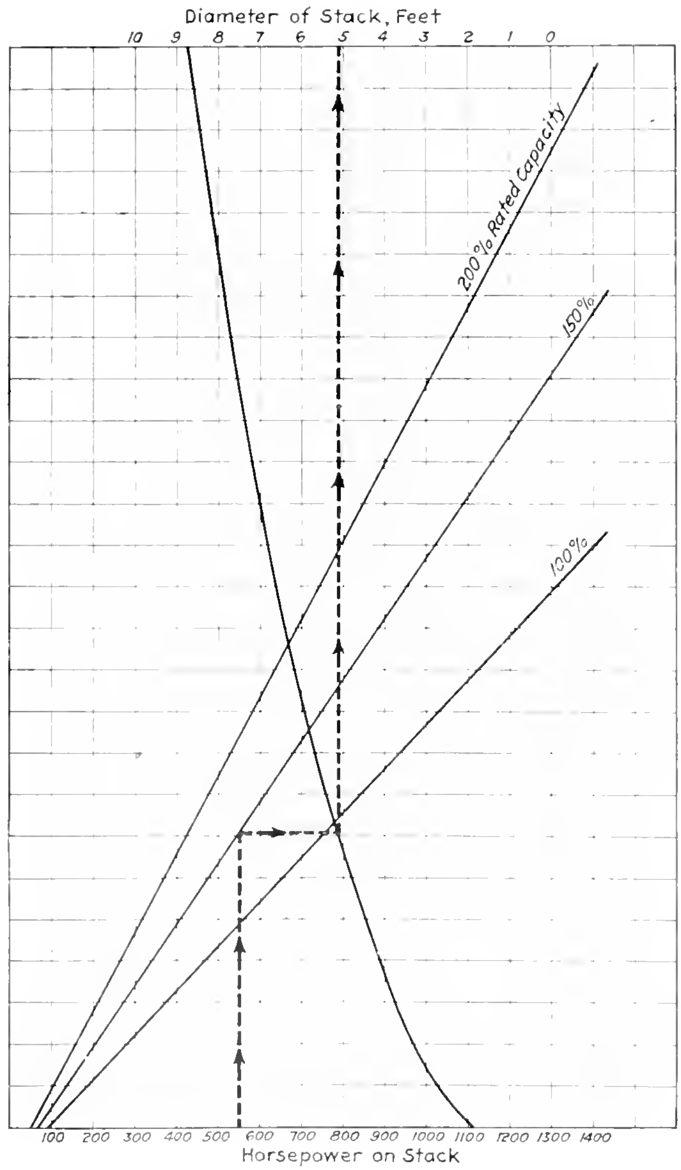


Fig. 4.

draft sufficient for operating boilers at about rating when burning coarse bituminous coal, but are inadequate for high ratings and for burning the finer grades of bituminous coal. and, of course, the fine grades of anthracite coal. This is quite clearly displayed in the charts.

It must be borne in mind that present practice is to place these stacks on top of boilers so that 8 feet to 12 feet should be added when height from the grate is considered.

Because of the tube area and the resulting high frictional loss through the tubes, extreme ratings of horizontal return tubular boilers are not possible, and commercially are seldom sought. There are times, however, when 200 percent of rating is sought and there are times when frictional resistance through the fuel bed is such that higher chimneys than standard are sought. The curves have been prepared using Mr. Menzin's formulae and gas velocities for use with horizontal return tubular boilers.

Assumed diameter curves

Rating	100	150	200
Efficiency, percent	65	65	63
CO_2	8	9	10
Stack temperature	450	500	550
Pounds of gas	85	77	73

The small circles upon the velocity curve represent present day practice of the horizontal return tubular boiler builders, and it is noted are in pretty close accord with Mr. Menzin's velocity curve.

This curve is represented in simplified form and its use is readily understandable. Taking an example: a 72-inch by 18-foot return tubular boiler (or 150 horsepower) is indicated with a dotted line and arrowheads, as follows:

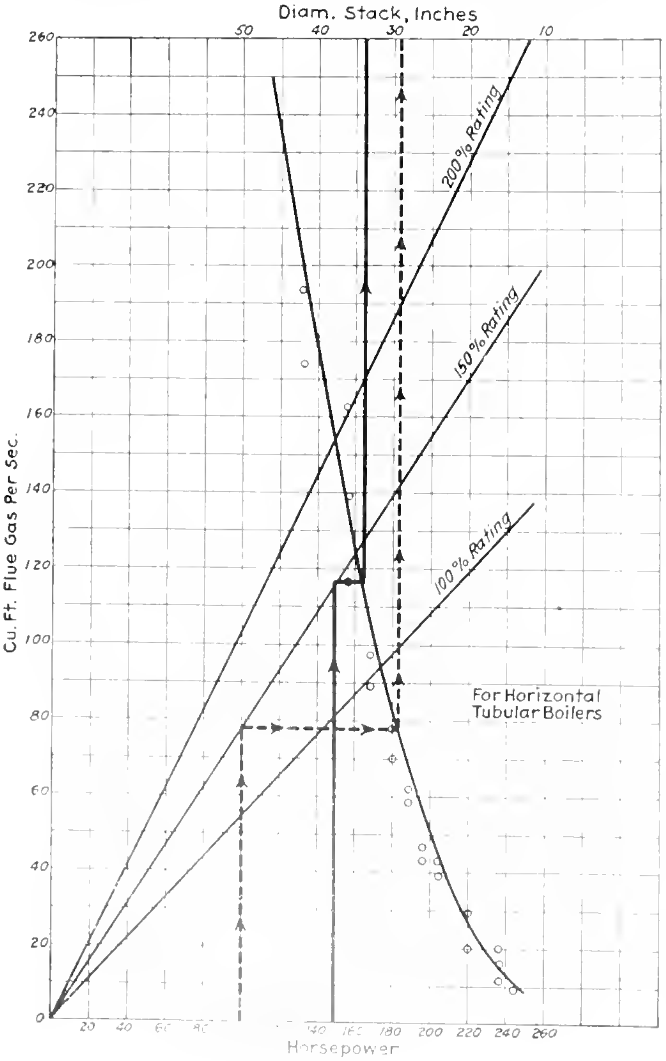


Fig. 5.

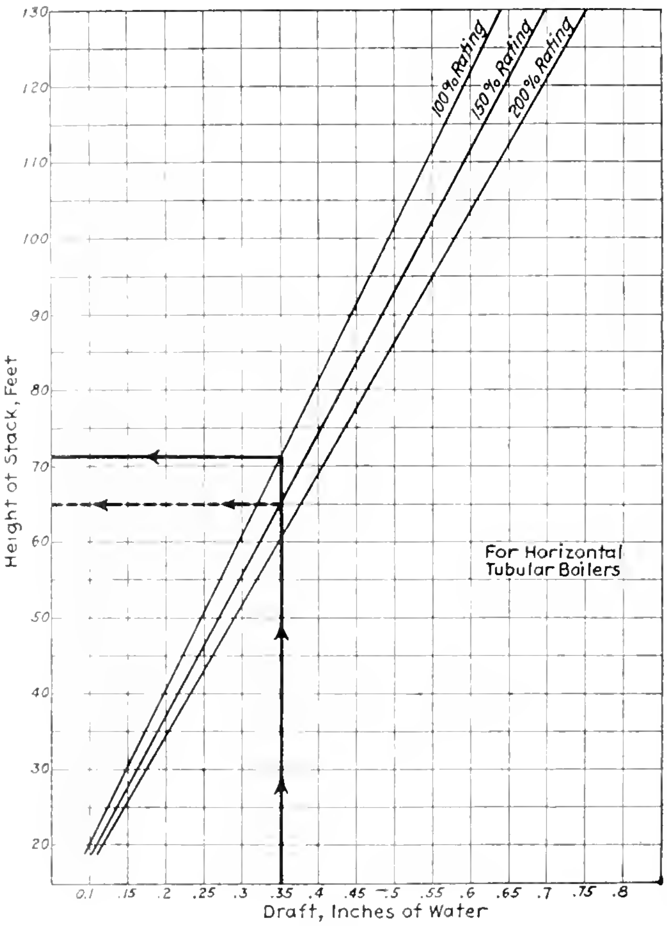


Fig. 6.

Rising vertically from 150 horsepower to the 150 percent rating line, thence horizontally to the high velocity line, thence vertically, we have the diameter of stack required, 34 inches. Then knowing the draft required in the furnace and the draft drop through boiler to stack, the height of stack required is very easily obtainable. Under ordinary conditions of 100 percent rating, with coarse bituminous coals from 0.3 inch to 0.35 inch will satisfy; but high drafts are necessary at higher ratings, or with small coals, or any other condition which increases resistance.

In conclusion I wish to make full acknowledgment of the assistance, in the preparation of this report, of Mr. A. G. Pratt, Mr. Starr H. Barnum, Mr. A. H. Blackburn, Mr. R. L. Beers, Mr. R. A. Foresman, Mr. Harry H. Bates and Mr. G. L. Bouton.

Inasmuch as the Stoker Manufacturers' Association has considered this report at its annual meeting and adopted as its standard the recommendations of the committee, it is hoped this association will do likewise. If the members of both associations adopt the method of proportioning chimneys set forth in the report, and put it into general practice, it is felt that it will soon become common practice among architects and consulting engineers, and undoubtedly afford relief to us all from troubles caused by lack of proper chimney proportioning.

Stack Tables for Reference (From Westinghouse Chart)

HEIGHT OF STACK FOR AVERAGE INSTALLATIONS (SEA LEVEL)

FORCED DRAFT STOKERS

Per Cent Rating	100	150	200	250	300
Draft Furnace	.15	.15	.15	.15	.15
Friction Loss (Boiler)	.18	.4	.65	.9	1.20
Friction Loss (Breeching)	.10	.10	.10	.10	.10
Total Draft Required	.43	.65	.90	1.15	1.45
Height of Stack (Ft.)	80	112	145	178	220

(*Continued on page 212*)

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CONTENTS

At a recent joint conference between the officers of the International Railway Fuel Association and those of the Master Boiler Makers' Association it was decided that future conflicts between the conventions of these associations would be avoided. As a result of this agreement, the 1924 convention of the Master Boiler Makers will be held at the Hotel Sherman, Chicago, May 20 to 23, 1924, the week before that of the Fuel Association.

With the two associations co-operating in this manner, it will be possible for the manufacturers of railroad and boiler supplies and equipment to arrange a single complete exhibit which can be transferred from one convention to the other, thus eliminating the necessity of providing and conducting two complete exhibits at the same time. It will also be possible for members who are required to attend both conventions to do justice to each of them.

From time to time attention is called through news items and editorials in trade journals devoted to the steel industry to the ever increasing extent of tank fabrication in boiler manufacturing plants. It is quite logical that the industry equipped as it is for heavy plate work should turn its production facilities to this lucrative allied field especially where it is possible to utilize available plant capacity for this purpose without expansion.

At present the greatest tank demand seems to be for oil storage, undoubtedly due to the recent tremendous expansion of certain of the country's oil fields.

During the first week of July a boiler and tank manufacturing concern located in the Middle West received a single order for 20 tanks of 55,000 barrels' capacity, another company this same week received orders for 30 tanks, while 5 tanks of 80,000 barrels' capacity were contracted for by a third company. In all, about 80 large sized tanks in capacities up to 80,000 barrels were ordered in this period. The steel plate orders for work of this character were correspondingly large. In this connection the quarterly plate requirements of one company for tank work alone was 5,400 tons.

A great deal of this business that did not go to the boiler works could no doubt be profitably contracted for by them especially during the summer months when boiler production usually falls off. In fact, heavy plate or tank work is a real asset to the business of any shop throughout the year.

The National Board of Boiler and Pressure Vessel Inspectors is to be congratulated upon the excellent progress which it has made in the past year. A year ago 503 boilers were registered with the Board by 18 concerns; today 6,387 boilers are registered by 35 firms making an increase for the year of approximately 1200 percent. No less than 14 states and half a dozen cities will accept without question boilers stamped with the National Board stamp and no instance has been recorded where a boiler stamped "National Board" was not a Code boiler.

Following its rapid growth during the past year, the National Board is now about to investigate the activities of dealers in second-hand boilers with the object of putting a stop to dangerous practices in this line of business. It is believed that rules and regulations governing the use of second-hand boilers can easily be established which will be as effective and as uniform as those for the manufacture and inspection of new boilers. In addition to this, the National Board will take into consideration the adoption of rules covering air and other pressure vessels, as it is found that explosions from such vessels are even more widespread and destructive than in the case of boilers.

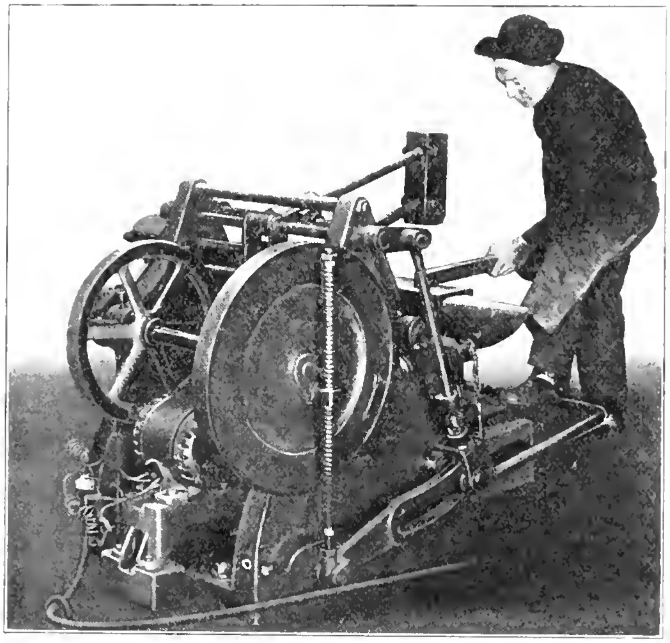
It is gratifying that this branch of the boiler making industry is making such rapid progress and it is hoped that its future efforts will receive even more substantial support from manufacturers and dealers alike in future.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

General Utility Power Smithing Hammer

A POWER-DRIVEN hammer intended particularly for use on forging work ordinarily performed under hand-swung sledges and too small to be done under steam hammers, is shown in the accompanying illustration. The hammer is termed a "mechanical helper," since it replaces the one or two men employed as strikers at each anvil. The same hand tools that the smith ordinarily employs are used with the hammer, without the need of special tools and dies. The hammer, which is stated to greatly increase the capacity and the output per anvil, has recently been placed on the American market by the Blacker Engineering Co., Inc., Grand Central Terminal, New York, N. Y.



Power Hammer for Forging Work

The machine is rated to handle material up to 2½ inches thick, although even larger sizes can be cared for. The hammer itself is under the control of the smith, so that either a light or heavy blow can be struck. The force of the blow varies directly with the depression of the treadle extending around the anvil. It is stated that the maximum blow is about four times as heavy as that delivered by a human striker, and that the machine attains a rate of 140 blows per minute.

An important feature of the hammer is the lateral traverse motion that can be given to the hammer itself. This motion is controlled by a winged foot lever located at the right of the anvil and enabling the head to be traveled along the face of the anvil to the desired point.

An anvil and a block of special design to suit the hammer are furnished. The base of the anvil is planed and adjusting screws are provided on the stand, to enable the anvil to be moved forward or backward to get the proper position under the hammer.

The hammer requires only 1 horsepower to drive it. It can be run by means of a belt from a lineshaft, being furnished with tight and loose pulleys 15 inches in diameter for this work. A more compact unit is the one driven by an individual motor, as illustrated. The motor is mounted on a small stand on the base and geared to a large driving gear placed on the main shaft. The hammer alone weighs 1,500 pounds, the anvil 560 pounds, and the stand 336 pounds.

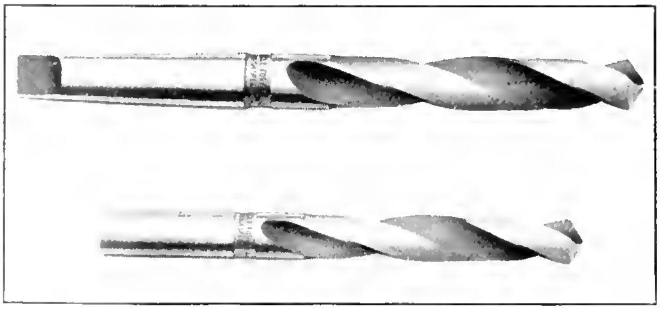
A New Development in Drill Making

FOR the past few years high speed drills have been made by two methods, first, by twisting a flat bar, or second, by milling from a round bar. The first involves a hot working process to form the flutes, followed in turn by a machining and a twisting process, or by a simple twisting process without the machining. In both cases the web is usually not central and efforts are made to return it to the correct position by a straightening process, a flute grinding process, or by both.

In spite of the additional toughness imparted to the drill by these methods, the second type of drill made from the full round bar by the milling process, has continued to be the one made and sold in largest quantities, and therefore the one most suitable to the general requirements of the metal-working industry.

The continued preponderance of the milled type of drill may therefore be attributed to the fact that the webs of such drills are centrally located by the milling machine. The drills are uniform and will therefore drill more uniform holes.

The drill point grinding machine insures that points of drills are ground correctly, and such machines should be in more general use than they are. This machine is, however, only a machine and can grind correctly only such drills as are made accurately and uniformly. If the web of a drill is not central, the point of the drill cannot be accurately ground in a point grinding machine. Drills with the web off center can be ground out at the point so as to bring the web central at first place, but this is a more skilled operation than point grinding by hand and it is one which is seldom, if ever, well done in the average machine shop.



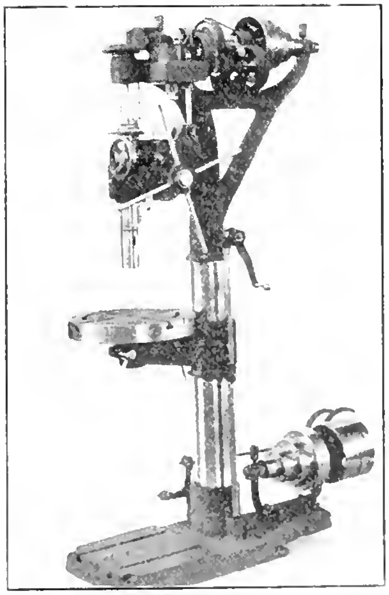
Cle-forge Drills Designed to Combine Toughness and Accuracy

It therefore follows that the ideal twist drill is one having the toughness of the hot-worked drill and the accuracy of the milled drill. It enables drills to be properly ground by machine and assists in removing the prejudice which apparently exists among mechanics against using these machines.

As a large manufacturer of both milled and forged drills the Cleveland Twist Drill Company, Cleveland, Ohio, has been experimenting with a view to placing on the market a single drill which would embody the advantages known to be possessed in part by the forged drill and in part by the milled drill. A process, said to accomplish this result, has been perfected and given the trade name Cle-forge. Cle-forge drills are hot worked where necessary to impart toughness and are afterward machined in the same manner as a milled drill. In fact they cannot be distinguished from the former milled product by mechanical inspection. Briefly Cle-forge drills are intended to unite in one tool all the advantages of both forged and milled drills so that their cutting quality and strength will surpass that of any former type of forged drill and their accuracy be equal to that of the milled drill.

Redesigned Vertical Drilling Machine

THE 20-in. vertical drilling machine illustrated has been recently redesigned by the Superior Machine Tool Company, Kokomo, Ind., to include bronze bushings, back gears, geared feed and wheel and pilot feeds. Flexibility is secured by the new design and with the unit method of assembly with all parts made on an interchangeable system, the machine may be converted or reassembled to meet varying requirements.



Superior 20-inch Vertical Drilling Machine

The feed box is provided with steel gears heat treated, reduction being obtained by a bronze worm and gear running in oil. Three feeds are obtainable by shifting a key in the feed box and three additional feeds by a sliding gear on the top shaft.

The column is well proportioned as shown in the illustration, being reinforced at sections subject to heavy strains. The drive provides for a 2-in. belt and pulley and 2¾-in. belt on the counter pulley, which gives all necessary power for drilling within the capacity of the machine. Ample provision for lubrication is afforded for all working bearings.

This machine can be adapted for motor drive with motor speeds varying from 750 to 1,800 r.p.m.

The height of the machine to the top of the pulley is 74 in., the spindle being 41½ in. above the base. The distance from the table to the spindle is 26 in., the traverse of the spindle sleeve being 8½ in. and the traverse of the table 23¼ in. This machine drills to the center of a 20¼-in. circle. Six spindle feeds from .005 to .018 in. per rev. are available. When belt driven, a driving pulley 9 in. by 3 in. running at a speed of 450 r.p.m. is used. This gives four direct spindle speeds from 970 to 875 r.p.m. and, with the back gears in, four additional speeds from 25 to 226 r.p.m. can be obtained. A one horsepower motor is required if the machine is to be motor driven.

A High Carbon Welding Metal

WELDING has proven its value in railroad applications not only in maintenance, construction and repairs but also as a reclamation medium particularly on low carbon steel parts. The reclaiming and maintenance of high carbon steel parts such as buffer castings, frog points, steel tires, etc., have somewhat suffered due to the fact that a suitable welding metal was not generally available.

The Page Steel & Wire Company, Bridgeport, Conn., has perfected a welding metal, the carbon analysis of which is practically 100 percent for welding high carbon parts by either the oxyacetylene or electric arc welding process.

The principal application of Page high carbon welding rods and electrodes is for the building up of worn surfaces where a high resistance to abrasive wear is desired. In electric arc welding this electrode maintains a stable and uniform arc. In gas welding the metal flows smoothly. With either process the finished weld may be ground but is not readily machinable.

Tests of Weld Deposits on .42 Carbon Steel

Original metal	
Carbon	.42
Brinell hardness test	58.5
Thickness of welded layer	5/32 in.

	Carbon	Brinell hardness test
Outer surface of deposit	.63	74.8
At a depth of 1/16 in. from top	.56	66.2
At a depth of 3/32 in. from top	.57	55.6
At a depth of [illegible]/16 in. from top	.46	58.0

The table shows a typical result of weld deposits when made on a steel of .42 carbon content indicating wearing qualities that are more than equal to the original material.

TRADE PUBLICATIONS

Twist Drills and Reamers.—The Latrobe Tool Company, Latrobe, Pa., has issued a catalogue of 112 pages listing and illustrating its line of high speed twist drills and reamers.

Boilers.—The Lebanon Boiler Works, Lebanon, Pa., has issued Bulletin 23-A which is a 23-page booklet containing a complete illustrated description of the Uniflow improved return tubular boiler; also illustrations of typical Uniflow installations and tables showing the absorption efficiency of fire tubes, horsepower ratings, CO_2 losses, etc.

Prevention of Foaming.—An instruction booklet entitled "Foaming, Its Cause and Prevention," written particularly for the benefit of enginemen and firemen, has been issued by the Bird-Archer Company, New York. The text sets forth the principle on which anti-foaming compound operates to prevent foaming and explains clearly the reasons for the simple instructions given for its successful use.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

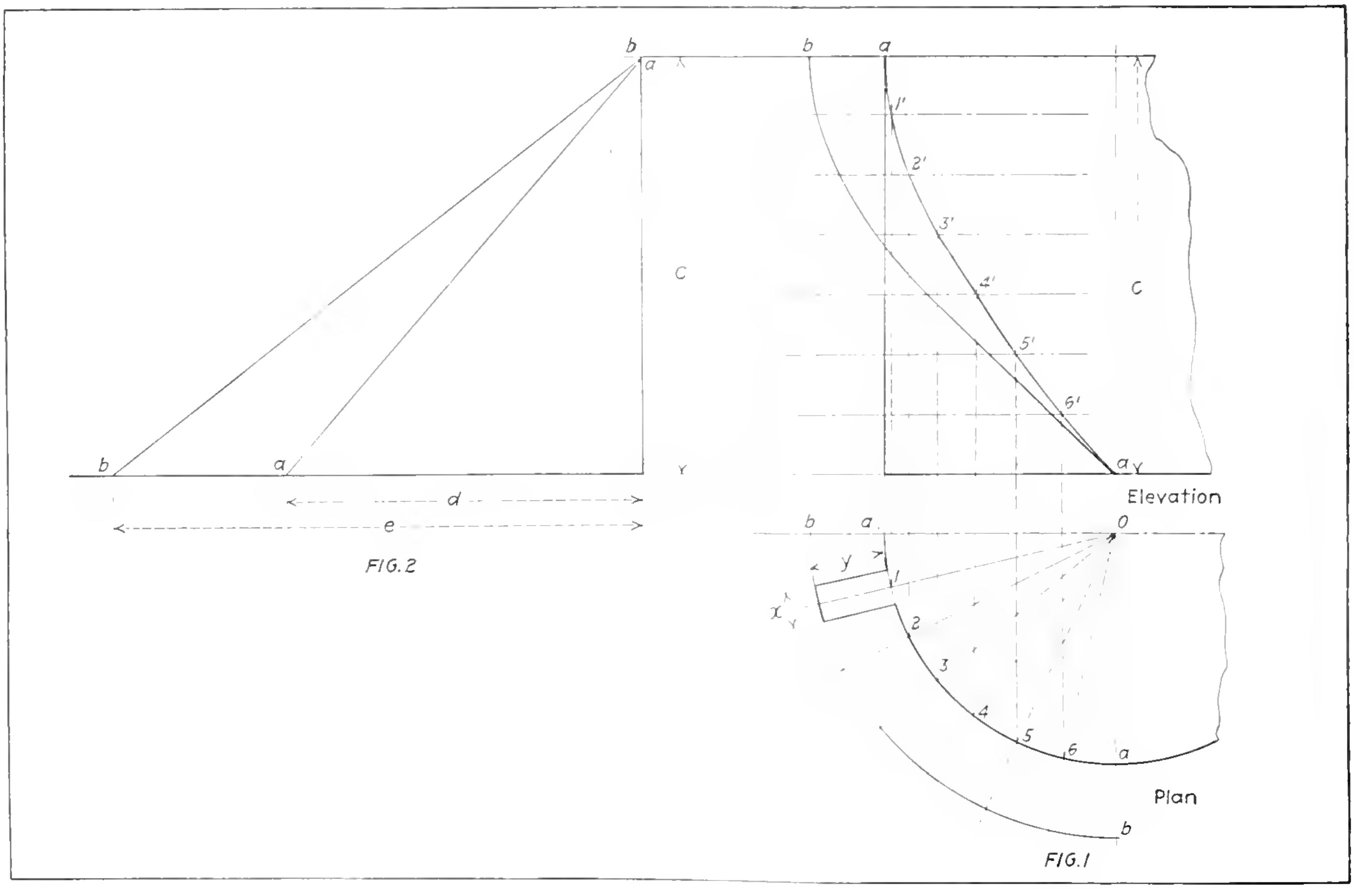
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Helical Stairs and Hemispherical Head Developments

Q.—Would you kindly tell me how to lay out a pair of winding stairs. Radius to inside of stairs, 49 feet 8 inches; arc length that stairs are to go around tank, 58 feet 10 inches. There are 55 steps or 56 treads. Height of tank, 48 feet 10 inches. This makes about one-quarter turn around tank. Please tell me how to find the length of the two channels that form the stairs and how to lay out the channels. Also will you give the layout and development of a hemispherical tank bottom in the next issue of THE BOILER MAKER having a radius of 7 feet inside and made of 8 plates 5/16 inch, thick.—A. P.

A.—The development of the helix for the inside and outside frames as required for a helical stair making a quarter turn around the tank, involves the drawing of a partial plan and elevation as shown in Fig. 1. With *o* as a center and *o-a* and *o-b* as radii (taken from point *o* to the inside surface of the frames) draw the arcs *a-a* and *b-b* in the plan. These arcs represent the path of the helical curves of the frames as they would appear in looking directly down on the tank. Divide one of the arcs into the required number of step divisions, but in this case to simplify the solution seven divisions are used. Divide the height *C* of the tank into the same number of parts, and through the points so located draw the horizontal projectors. From 1, 2, 3, 4, etc., draw vertical projectors to intersect the horizontal ones of the elevation, thus locating points 1′, 2′, 3′, 4′, etc., which are the required points for drawing in the helix for the frame. The outside helix for the outer frame is developed in the same way.

The lengths of the helices are determined in Fig. 2. The height *c* and the base dimensions *d* and *e* form two right angle triangles of which *d* equals the arc length *a-a* of the plan and *e* equals the arc length *b-b*. The hypotenuse *a-a* of Fig. 2 is the required length of the channel near the tank and *b-b* the length of the outside channel support. A small

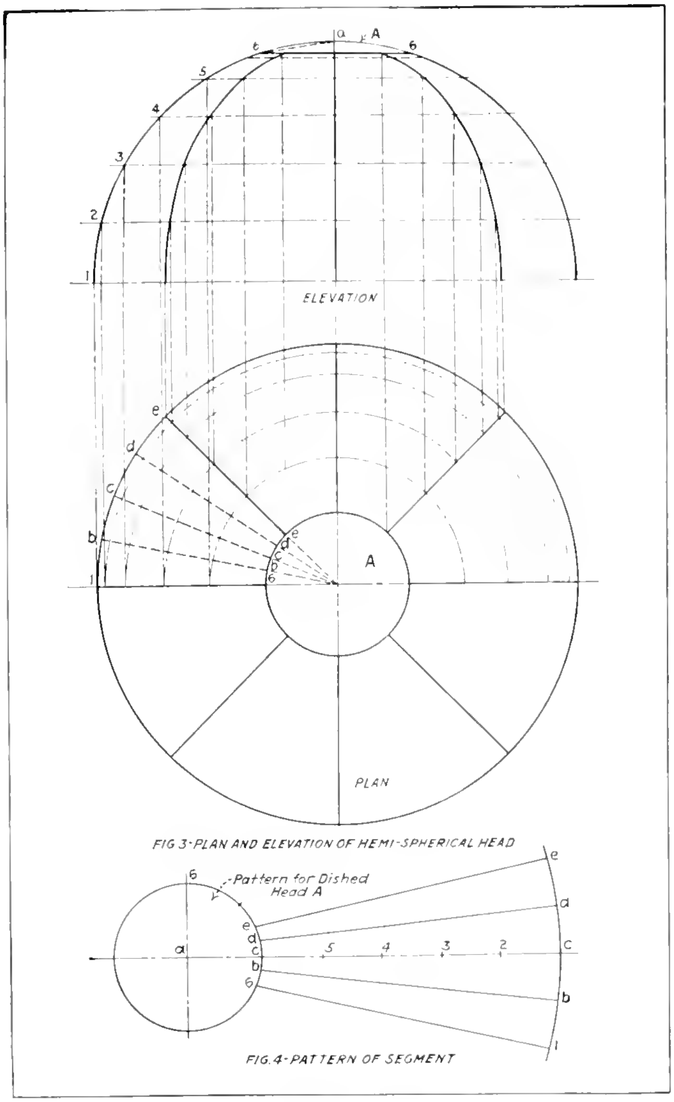


Partial Plan, Elevation and True Lengths of Lines in Spiral Stair Development allowance should be made in these lengths for working up the channels to the required shape.

The step layout consists of transferring the respective dimensions x and y of Fig. 1 to form a template, from which the remaining steps can be marked off.

DEVELOPMENT OF HEMISPHERICAL HEAD

A simple solution for developing a hemispherical head is given in Figs. 3 and 4. The plan is divided into the required number of segments and the bottom is finished with a bumped head, *A*. The outer curve *1-6* of the segment is is divided into a number of equal divisions as required for developing the pattern or a better way is to run off the length with a traveling wheel. The respective dimensions for the head and segments should be laid off to the center of the plate, for in working the plate there are certain changes that occur for which plate allowances would otherwise be essential in the pattern layouts. At the center of the plate no change occurs and a pattern laid off therefrom will give the required size of the pattern.



Simple Layout for Hemispherical Head

The arc length *1-e* of the plan is divided into a number of parts for setting off the stretchout at the bottom of the segment pattern.

It will be noted that the inner arcs of the segment as taken on the edge lines are shown developed in the elevation. This part of the work is not essential.

In Fig. 4, the pattern for the bumped head is drawn with a radius equal to *a-6* of the elevation of Fig. 3. Divide 1/8 of the circle into 4 equal parts, as shown from *6* to *e* and on the line *c-c* set off the arc length *1-6* of the elevation, Fig. 3. From point *c*, Fig. 4, set off the arc length *1-6* of the plan view and from points *b* and *d* of the circle, Fig. 4, set off the length *c-c*. From points *6* and *e* set off the same length to intersect the arcs drawn from *b* and *d* at the bottom of the pattern, thus locating the points *1* and *e*. Draw in the curve through *1-b*, *c-d* and *e* and allow for the side lap.

A Peculiar Boiler Accident

Q.—We have a floating hoister, as it is called at our yard, which was sent out to float a sunken vessel in the Delaware River. The hoister finally sank during the operation. When it was recovered and brought back to the yard, the engineer related his experience to me. He said that when the hoister sank he was positive that he had nearly 100 pounds of steam up and of course she would blow at 100, which he claimed would help some. He also said that all the tubes were shot and that a new set of 206 two-inch tubes would be required to put the boiler in condition again after the sudden contact with cold water. I, having my doubts, but not being sure, had two men fill the boiler with water (barreled up) and no signs of any leaks were visible. I had the water dropped down the gauge glass and a fire started. According to the amount of fuel at hand, I was only able to get up 60 pounds steam pressure and, at this pressure, there were no signs of any tube blow outs or otherwise. In fact, one tube had been plugged for over a year and that tube in particular was as good as when first put in. In not being able to find any defects I am writing you for your opinion. Where would the steam under 100 pounds pressure go in coming into sudden contact with cold river water? This boiler had two safety valves but boiler sank pretty fast with hoister. Why did not the boiler explode? There have been many differences of opinion of this accident, so I thought that perhaps you could tell me.—F. C. C.

A.—The fact that the boiler did not explode under the conditions mentioned shows that it was strong enough to withstand the additional stresses arising from the rapid cooling of the boiler materials.

As the hoister sank the water extinguished the fire in the firebox before the boiler was entirely enveloped, therefore, the only possibility of a greater evaporation of water into steam was from a sudden release of the pressure due to a rupture of the boiler shell, heads or tubes, which did not occur.

The violence of a boiler explosion arises from the stored energy in the heated water, which, upon being released, expands into a much larger volume.

The steam in the boiler in this instance condensed as the plate and heated water cooled off.

Question on Tank Supports

Q.—Will you please give some more light on the formula $\frac{8^4}{8^4 + 10^4}$ for finding the load on the beam has been derived. This formula will be found in the March, 1923, issue of THE BOILER MAKER, Questions and Answers column, "Tank Support Calculations." T. L.

A.—The formula for computing the proportion of the load on each span is based on the deflection of the structural member of each span. The derivation of the formula is based on higher mathematics. The formula is used in practice, and its application is the important consideration.

Number of Courses in Standard Horizontal Return Tubular Boilers

Q.—As I am a practical boiler maker and a subscriber of THE BOILER MAKER I want you to answer this question for me by return mail, if you please. What is the best type of boiler for stationary work, a two course boiler with return flues and a quadruple riveted butt seam, or a three-course boiler with return flues and a quadruple riveted butt seam? These boilers are 200 horsepower and 20 feet long.—R. S.

A.—Horizontal return tubular boilers of this size are ordinarily built of three courses. The three-course boiler for such a length is the best for the reason that the narrower sheets are more easily fabricated and that the circumferential seams give the necessary rigidity in the support of the shell. The standard boiler sizes of this type 60 inches and over in diameter are made in three courses.

Diameters and Heights of Stacks for Steam Boilers

(Continued from page 206)

STACK TABLES (FROM WESTINGHOUSE CHART)

Computed for Brick Chimneys at Sea Level for a Friction Loss of One-Tenth Inch of Water Per 100 Ft. of Height

Sq. Ft. of Boiler Heating Surface	Diameter of Chimney in Inches Per Cent of Boiler Rating					Rated H.P. of Boiler Based on 10 Sq. Ft. of Heating Surface per B.H.P.
	100	150	200	250	300	
500	21	24	27	29	31	50
1,000	24	32	34	36	41	100
1,500	31	36	41	45	48	150
2,000	36	42	45	52	55	200
2,500	38	44	48	55	60	250
3,000	41	48	53	58	64	300
4,000	48	54	61	67	72	400
5,000	53	60	68	74	80	500
6,000	55	65	72	77	86	600
7,000	62	69	78	84	92	700
8,000	65	74	82	89	98	800
9,000	67	78	85	93	103	900
10,000	72	81	91	98	106	1,000
12,000	74	88	98	104	112	1,200
14,000	79	92	104	110	120	1,400
16,000	86	98	110	118	128	1,600
18,000	92	104	114	124	134	1,800
20,000	96	108	120	128	140	2,000
25,000	104	118	128	140	150	2,500
30,000	110	124	136	148	162	3,000
35,000	126	132	146	158	172	3,500
40,000	124	139	154	168	180	4,000
45,000	128	144	159	174	187	4,500
50,000	134	148	164	180	194	5,000
60,000	144	162	178	194	208	6,000
70,000	150	172	199	206	222	7,000
80,000	160	181	198	218	234	8,000
90,000	168	190	210	228	245	9,000
100,000	174	198	220	238	256	10,000

DATA ON WHICH TABLE IS BASED

Efficiency	[illegible]	68	68	65	[illegible]
CO_2	9	..	10	..	11
Stack Temp	450	..	525	..	600
Lbs. Gas B H P. Hour					

CORRECTION FOR ALTITUDE

Height Above Sea Level (Feet)	Ratio Increase in Diameter	Ratio Increase in Height
0	1.000	1.000
1,000	1.015	1.046
2,000	1.030	1.097
4,000	1.063	1.205
6,000	1.096	1.221
8,000	1.130	1.456
10,000	1.165	1.61[illegible]

Diameter of Chimney in Inches for Horizontal Return Tubular Boilers				Height of Stack in Feet For Sea Level and 60° F. Outside Temp. Assumed Friction Loss in Stack 0.1 Inch Per 100 Feet			
Nominal H.P.	100% Rating	150% Rating	200% Rating	Draft at Base of Stack	100% Rating	150% Rating	200% Rating
15	13	14	17	.12	21	22	25
20	14	16	18	.15	26	28	30
25	16	18	20	.20	35	37	41
30	17	19	21	.25	43	46	51
35	18	20	22	.30	52	56	61
40	19	21	23	.35	60	65	71
50	20	23	25	.40	69	74	81
60	21	24	27	.45	78	84	91
75	23	26	29	.50	86	93	101
90	25	28	31	.55	95	102	111
100	26	29	33	.60	104	112	122
115	27	31	34	.65	112	121	132
125	28	32	35	...	...	...	...
150	30	34	38	...	...	...	...
175	32	36	40	...	...	...	...
200	33	38	43	...	...	...	...
210	34	38	44	...	...	...	...
[illegible]	35	40	45	...	...	...	...
250	36	41	47	...	...	...	...

Data on Which Tables Are Based

Rating	100%	150%	200%
Efficiency	65%	65%	63%
CO_2	8%	9%	10%
Stack Temp	450	500	550
Lbs. of Gas	[illegible]	77	73

See Table for Large Stacks for Breeching Losses and Altitude Corrections.

AVERAGE FRICTION LOSS THROUGH BOILERS

Per Cent Rating	100	150	200	250	300
Loss Ins. Water	.1 to [illegible]	.2 to .6	.3 to .9	.5 to 1.4	.7 to 1.9

Friction loss through boiler varies according to construction.

For Furnace Draft.—Allow [illegible] for forced draft; For natural draft .35 inch or higher should be used depending upon rate of combustion and fuel used.

For Breeching Friction Loss.—Allow .05 inch for each right angle bend and .1 inch per 100 ft. of length. Cross sectional area should be 20% larger [illegible]

HEIGHT OF STACK IN FEET

For Sea Level and 60° Outside Temperature and 0.1 Inch Friction Loss Per 100 Ft.

Total Draft Reqd Ins. for Furnace Boiler and Breeching	Per Cent of Boiler Rating				
	100	150	200	250	300
.3	56	...	...	...	...
.4	74	69	...	.	...
.5	93	86	81	...	...
.6	111	103	97	...	...
.7	130	120	113	108	...
.8	148	138	129	123	...
.9	...	155	145	139	132
1.0	..	172	161	154	147
1.1	..	190	177	170	162
1.2	.	...	194	185	176
1.3	..	...	209	200	191
1.4	..	...	226	216	206
1.5	...	...	...	231	221
1.6	...	...	...	...	236
1.8	...	...	...	...	265
Assumed Flue Gas Temp.	500	550	600	650	700

PERSONALS

Edwards R. Fish was born at Stone Mountain, Georgia, on August 4, 1870. He attended public schools in Kentucky, Texas and St. Louis. After his graduation from the St. Louis Manual Training School he entered Washington University from which he received the degree of Mechanical Engineer in 1892. In March, 1893, he became associated with the Heine Boiler Company in St. Louis and has served that company continuously in various engineering capacities. His activities included testing, design, installation and manufacturing. He is at present a vice-president of this company and a member of the board of directors. Mr. Fish has been an active member of the American Society of Mechanical Engineers since 1914. He has been a member of the Boiler Code Committee since 1918 and chairman of the Sub-Committee on Air Tanks and Pressure Vessels since its formation in 1919. He is also a member of the Main Committee on Power Test Codes, chairman of the Individual Committee on Boilers, and a delegate of the Society to the American Engineering Council. At a recent meeting of the Nominating Committee, he was named as one of the managers of the Society for the coming year. In June Mr. Fish was elected president of the American Boiler Manufacturers' Association. He represents the Association in the American Uniform Boiler-Law Society. He is past-president of the Engineers Club of St. Louis and for many years has been active in its work.

E. R. Fish

C. C. Rosser, who for many years has been connected with the Detroit Seamless Steel Tube Company, has been appointed district sales manager, with offices at 1206 Guardian Building, Cleveland, Ohio.

OBITUARY

John B. Wolters, for the last few years United States inspector of boilers and machinery for the Bureau of Navigation, Department of Commerce, died in San Francisco recently, after a long illness. He was well known along the water front. He is survived by a widow, Mrs. May Wolters, and a son, John B. Wolters, Jr., boiler inspector for the New York Underwriters.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Explosion of Vertical Tubular Boiler

THE recent explosion of the vertical tubular boiler, shown by Fig. 1, at Algoma, Wisconsin, emphasized the reasonableness of modern requirements dealing with boilers of that kind, and that the pressure carried in the older boilers should be reduced as their age and changed conditions may necessitate.

The boiler which exploded was operated, and presumably owned by a contractor constructing a new bridge at Fourth street, in that city, and not only were the employes exposed to the danger of injury, but the public, whose safety must be protected by the use of the greatest precautions, had clearly recognized rights in the vicinity. The papers report the presence of numerous persons within two hundred yards of the place at the time of the accident, and three people

Fig. 1.—Shell of Boiler After the Explosion

are said to have been within six feet of the boiler not more than five minutes preceding the explosion.

Cause of Failure

The explosion was the direct result of the failure of the firebox sheet, which pulled free from the staybolts, and split vertically. A part of the sheet curled up against the firebox tube sheet, while another part was projected downward around the mudring. This left an opening about one-fourth the circumference of the boiler, through which the water and steam were projected, causing the boiler to sky-rocket.

The boiler was projected over 125 feet into the air, and in descending cut the wires carrying high voltage electric current from the High Falls plant to the cities on the north, so that added source of danger required the efforts of the police department to prevent injury to the crowd which quickly gathered.

The loss sustained by those dependent upon the electric current for power and light was considerably greater than the damage which resulted directly from the explosion, as a number of industries in Sturgeon Bay and vicinity were forced to shut down until the wires could be repaired and transmission of current re-established.

The pressure carried at the time of the accident was 125 pounds, and the pressure gage was observed some fifteen

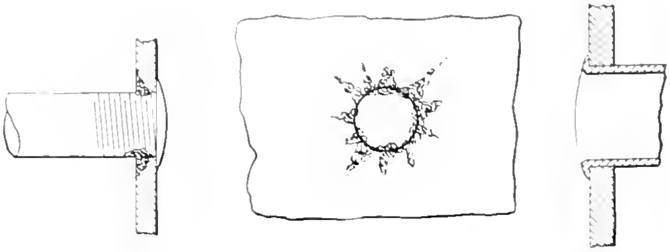


Fig. 2.—One Method of Repairing a Boiler Where Staybolts Have Deteriorated

or twenty minutes before the explosion occurred. So far as could be learned, the boiler had been operated at that pressure for an indefinite time, and is said to have been represented as safe by the party from whom it was purchased.

Details of Boiler

The boiler was 44 inches in diameter by 90 inches in length. The shell plate was constructed of a single sheet ¼ inch in thickness, and the firebox side sheet was made from material of the same gage. The staybolts were ¾ inch in diameter at top of thread, and the pitch at the centers was 8 inches by 8 inches. The safe working pressure, based upon the load permitted on the staybolts by modern rules of boiler construction, was about 34 pounds, if we do not take into consideration the fact that ¼-inch firebox sheets are not permitted, the minimum being 5/16-inch.

The staybolt heads may have been of sufficient size and properly formed, when the boiler was new, but use and abuse had reduced the size of the heads at the firebox end of the bolts, and many of the heads were badly split, probably the result of redriving. The staybolt holes in the fire-

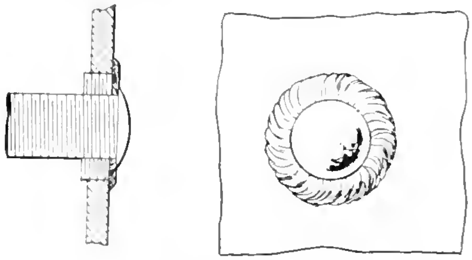


Fig. 3.—"Sun Flower" Repair Where Staybolt and Sheet Have Corroded

box sheet had no doubt been of proper size and threading, but the feed water used at some operation had affected the joint of sheet and staybolt to such an extent that little, if any, holding power remained, as illustrated by Fig. 2. This form of deterioration is not unusual, and may jeopardize the safety of a well constructed boiler if used with feed water containing certain acids. If but one bolt and the surrounding sheet are affected, temporary repairs may be made by cutting the hole in both inside and outside sheets, after the bolt has been removed, to fit a tube 1 inch or 1¼ inches in diameter. The size of tube necessary will, of course, depend upon the extent to which the sheet has corroded. A repair of this kind is shown by Fig. 2. However, if proper tools are at hand, or if several of the staybolts are to be removed, on account of corrosion of the sheet, it is better to use a sunflower, illustrated by Fig. 3, rather than to use the tube in making repairs. The sunflower is more dependable, and its use avoids the necessity of enlarging the hole in the shell plate.

When a boiler of this type, or, in fact, any waterleg boiler is being retubed, or given other repairs in the shop, the boiler maker on the job may be of real benefit to an indefinite number of people, by examining the sheets and staybolts carefully for corrosion, and by making necessary repairs.

Chicago, Ill. J. P. MORRISON.

Gusset Sheet Layout

In my opinion the method of laying out a gusset or slop-barrel sheet, as illustrated on page 182 of the June issue of THE BOILER MAKER, is very good for use on small jobs where the center "X" can be reached with trammel points. It is, however, impractical for the slope course of the average boiler where the taper is comparatively small, since it will be found necessary to make the layout to scale and then transfer it full size to another sheet.

For such a job I much prefer to use simple triangulation as is illustrated on page 236 of the third edition of "Laying Out for Boiler Makers." A little care in working up the triangles will give as accurate a result as could be desired; and when the layout must be made to scale by the former method, the latter will be found much quicker.

Houston, Tex. R. L. PHELPS.

In the Interest of Better Boiler Inspection

A FEW weeks ago one of the leading railroads of the country has had two disastrous explosions of locomotive boilers, in which the loss of life was great and several persons badly injured. The papers state the cause in both cases as unknown and from this it is plainly seen that someone is withholding the facts.

Why does the public not learn the truth of such a situation. The example of these two explosions would tend to make others more cautious. It is stated that one of the locomotives had just left the shop the day after receiving repairs. Certainly, if this was the case someone was negligent in his work or else the accident was unavoidable. We do know that the locomotives of the country are in a terrible condition, yet they are allowed to operate.

The government not having a force large enough to cope with the situation is at present taking the matter up with Congress to enlarge the staff by 35 more additional inspectors.

There are men holding down the position of boiler inspectors in the shops of the country who are not qualified to hold such responsible positions. There is no rule or regulation whereby the inspector is required to pass an examination as to his ability and fitness to inspect. The laws in many states in regard to inspectors of stationary boilers now require the inspector to pass an examination to show whether he is competent to inspect or not and if not, he is not given authority to inspect. Yet a locomotive boiler carrying from 50 to 100 percent more pressure than a stationary boiler can be inspected by anyone the company puts on the job and the mechanical officer in charge is held responsible.

What authority has a company inspector anyway? He inspects the boiler and notifies the gang foreman or foreman of the defects. The gang foreman or foreman goes over the points mentioned and, if he has time, will do some of the work and, if not he "lets it slide," as the saying goes.

I have seen cases where loose staybolts were allowed to be put in and loose rivets calked up to make them tight. I mean real loose and not merely ones that were sweating. I am at present working in a railroad shop and will say that engines are being operated under conditions that are very unsatisfactory, it being impossible to give them the necessary repairs, owing to the fact that the traffic is exceedingly heavy and must move.

Certainly the traffic should move, but is that any sign that the public and the railroad man should take their lives in their hands in order that traffic be kept on the move? Engines are being operated with many cracked and broken bolts, more than the limit placed in Rule 25 of the Interstate Commerce Commission Rules and Regulations.

Recently we removed 10 cracked staybolts, all located adjacent to each other and old breaks. Electric welds are found that are improperly done, the welder not cleaning the sheets and seams prior to welding in order to obtain clean surfaces but merely sticking the weld on any old way possible.

On boiler test, I have noticed that the crown bolts are not tested at all and only part of the other staybolts. It is time some action was taken to eliminate these dangerous conditions and practices or else we will have more explosions than we have ever had before. The machine work on the engines is no doubt in the same condition.

Olean, N. Y. C. W. CARTER, JR.

Cost Accounting

(Continued from page 195)

(2) Administrative and selling overhead is made up of such items as

Donations.
Postage.
Telephone and telegraph.
Salaries.
Administrative salaries, etc.

and the rate for this should be determined in the same way as the factory overhead but, instead of charging same on the cost each month it should not be charged on the cost until the order is completed and billed; that is, the administrative and selling overhead is taken care of by the number of hours included in the cost of the contract regardless of the number of productive hours performed during the month that the charge is made.

In conclusion, the writer wishes to say he has endeavored to present a concise article laying down fundamental principles underlying all costs and has purposely not enlarged or gone into the intricacies of cost accounting, the purpose being that no matter how small the plant may be a cost system should be installed.

Nationwide Investigation Into Apprentice System

Appointment of a committee to make a nation-wide investigation of the apprentice system has been announced by the American Management Association, composed of many of the country's largest industrial enterprises. The committee, headed by L. L. Park, supervisor of welfare, American Locomotive Company, Schenectady, N. Y., was named by the Plant Executives' Division of the Association, of which Sam A. Lewisohn of New York, vice-president of the Miami Copper Company, is chairman.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.
Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

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Secretary—C. W. Obert, 29 West 39th Street, New York.

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Statistician—W. E. Murray, Seattle, Wash.

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William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Master Boiler Makers' Association

President—E. W. Young, mechanical assistant to G. S. M. P., C. M. & St. P. R. R., 787 Caledonia Place, Dubuque, Iowa.
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Executive Committee—George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Can.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill., and A. G. Pratt, The Babcock & Wilcox Company, New York.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va	Seattle, Wash.

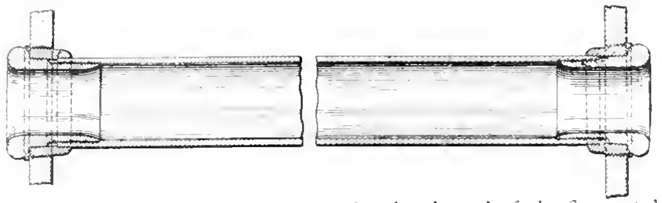
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,457,753. BOILER-FLUE SETTING DEVICE. FREDERICK SCHMITT, OF OAKLAND, CALIFORNIA.

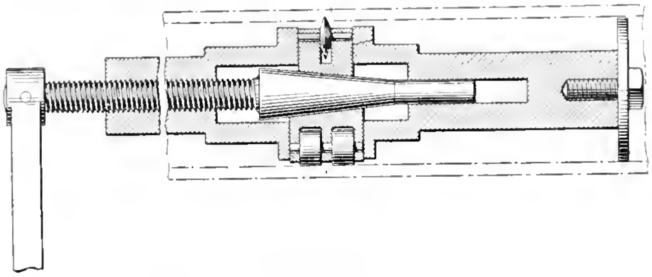
Claim 1.—In combination, a flue sheet provided with a flue opening, a flue, a bushing adapted for insertion in said opening from the outer side of said flue sheet and extending slightly beyond the inner side of said flue



sheet so as to form a supporting extension for the end of the flue seated therein, said flue terminating short of said flue sheet, and a clamping and securing member adapted for insertion from the corresponding side into the mouth of the flue. Five claims.

1,457,258. BOILER-TUBE CUTTER. MICHAEL MAHER, OF BAY CITY, MICHIGAN.

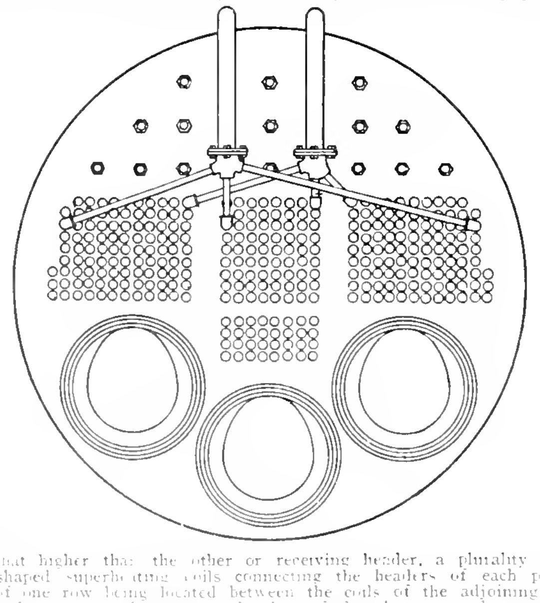
Claim.—A tube cutter including a body adapted to be inserted into the tube to be cut, a cylindrical chamber formed in said body, said chamber merging at one end into a blind bore and at the other into a threaded bore, a cone formed at one end with a spindle to fit into said blind bore and at



the other with a threaded shank guided in said threaded bore arranged in said cylindrical chamber, said body adjacent its center between its ends presenting an opening merger into said cylindrical chamber, and a block carrying a circular cutter at one side and formed at the other with a tapering face transversely curved and longitudinally arranged in said opening, said tapering face of said block mating with the tapering surface of the cone so as to move laterally when the cone is moved longitudinally.

1,453,638. BOILER SUPERHEATER. CYRIL SAMUEL DRAYTON PERRY, OF PORT ARTHUR, ONTARIO, CANADA.

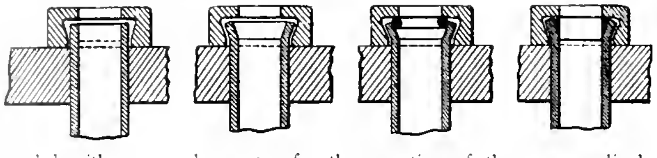
Claim.—The combination with a boiler having a plurality of furnaces of a superheater for each furnace comprising a pair of elongated hollow casings, supported in the upper part and on opposite sides of the furnace fire box, one of said headers constituting the delivery header and being positioned



somewhat higher than the other or receiving header, a plurality of rows of S-shaped superheating coils connecting the headers of each pair, the coils of one row being located between the coils of the adjoining row, a saturated steam supply pipe, a plurality of distributing conduits extending between said supply pipe and the receiving headers of the superheaters.

1,456,145. FERRULE FOR BOILER TUBES. JOSEF PECINKA, OF DEUTSCH-WAGRAM, AUSTRIA.

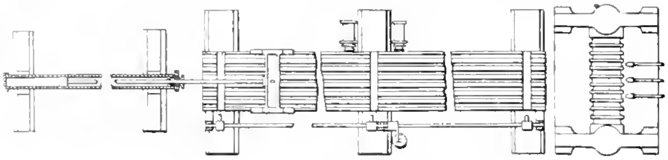
Claim.—A boiler tube ferrule comprising a cap of a refractory material provided with an inner circumferential groove having a tapering side wall



provided with an annular recess for the reception of the correspondingly shaped end of the boiler tube protruding from the boiler, and a ring within said annular recess for connecting the end of the tube within and with said ferrule, substantially as described.

1,453,203. TUBE ROLLING MILL. RALPH C. STIEFEL, OF ELLWOOD CITY, PENNSYLVANIA.

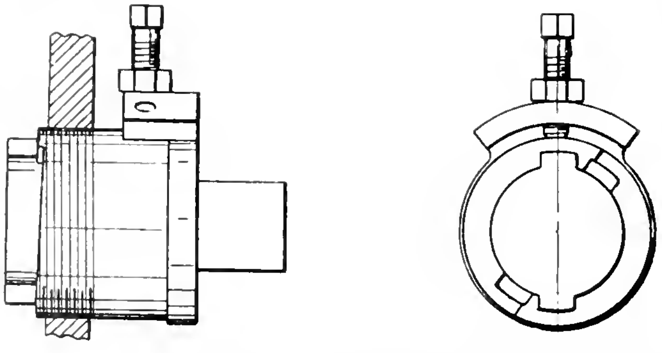
Claim 1.—In a rolling mill, the combination of grooved rolls provided with a large number of working grooves arranged in several series each comprising a plurality of grooves, a table in front of said rolls and provided with



a plurality of blank supports corresponding in number to the number of grooves in the rolls which comprise a single series, said table being arranged to be bodily shifted sidewise to bring its blank supports into line with any one of the series of working grooves in the rolls, and means mounted on said table for transferring blanks from one blank support to an adjacent one. 3 Claims.

1,457,911. BOILER PLUG. PETER E. McINTOSH AND RUSSELL O'CONNELL, OF KALAMAZOO, MICHIGAN.

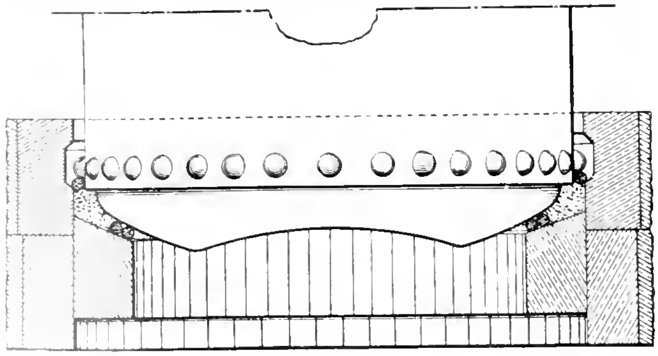
Claim 1.—In a structure of the class described, the combination of a screw bushing with a bearing seat at its outer end and an inner end divided into opposed symmetrical spiral surface with longitudinal slots leading thereto, a plug with a flanged bearing to fit the bearing at the outer end of



the bushing and with longitudinally projecting opposed lugs adapted to pass through the longitudinal slots and engage the said spiral surfaces, a square projection on the plug for turning the same, a transversely projecting plate carrying a curved segment with a series of screw holes, a set screw for insertion through the said segment to lock the plug in closed position, and a lock nut for the set screw, as specified. Six claims.

1,457,281. BOILER CONSTRUCTION. EDGAR KIDWELL, OF MILWAUKEE, WISCONSIN, ASSIGNED TO KIDWELL BOILER COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

Claim 1.—A boiler having a setting with an opening in the wall thereof, and a drum having its head and a portion of its cylindrical shell loosely entered in the opening, said opening being formed by a ring structure built into the setting and presenting two internal face portions whereof one en-



[illegible] the shell and is in spaced relation thereto and has an annular groove [illegible] proximity to the drum head rivets, and whereof the other face portion [illegible] and in spaced relation to the drum head, and packing material [illegible] between the ring structure and the adjacent portions of the drum [illegible] so as to bear against the opposing rivet heads and be re- [illegible] Three claims.

The Boiler Maker

AUGUST, 1923

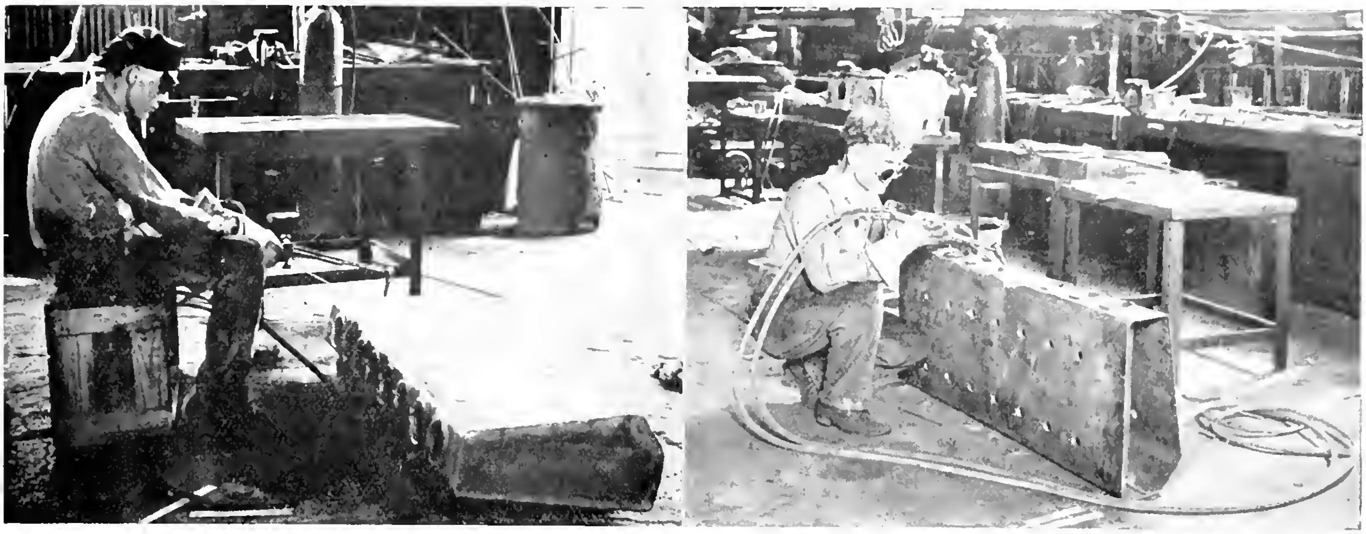


Fig. 1.—Welding Operations on Smoke Consumer

Welding and Cutting Practice in the Boiler Shop

In the building of low pressure boilers, in pressure vessel construction, and in repair work, there are many acceptable applications of welding which speed up production and cut operating costs. The following article deals with a number of jobs, both welding and cutting, in which the oxy-acetylene process has been used with a high degree of success.

THE low pressure steel boiler industry offers many applications of the oxy-acetylene process in the manufacture, maintenance and ultimate disposition of its products. Welding and cutting is applied in various operations from the time the plates are brought into the shop, until the boiler is finished, it is applied at intervals throughout the life of a boiler for repairs and the worn out boiler is finally reduced to scrap with the cutting blowpipe.

When the sheets are received by the layerout they are often cut once to render them easier to handle. Such parts as dome saddles and throat sheets and openings such as manholes and clean out holes are easily cut at this stage of production to exact measure with a cutting blowpipe.

The sheets then leave the layerout for the shears and punches where unfortunately mistakes are sometimes made. A hole punched in a wrong place can, however, be welded in many cases and the sheets saved. A plate edge or angle iron damaged by the shears can be similarly reclaimed.

Reclaiming Cracked Flanges

Boiler steel is of high quality, but flanges crack despite the utmost care both in flanging and in fitting up or assembling. Here again seemingly vital defects are easily corrected with the welding blowpipe. In fitting up, the dome of course must be driven down into the saddle, the mud ring into the water space. The old-fashioned heater bar, formerly used to help fit these heavy parts, is now being supplanted to a great extent by the oxy-acetylene blowpipe, which, by applying a maximum of quick heat to a small area, permits the parts to be fitted easily and properly. Staybolts are cut off to exact length for driving after they are inserted, and if, as occasionally occurs, the staybolt hole is made too large in tapping, instead of using an over-size bolt the hole is welded and another of correct size drilled and tapped.

Patching firebox sheets is a common application of oxy-acetylene welding. Calked edges in riveted fireboxes deteriorate so that either new sheets must be installed at considerable expense or the edges reclaimed by welding, which costs very little.

Firms Have Had Long Experience with Welding

In Chicago a well-known boiler manufacturer has been using the oxy-acetylene process for over 10 years in the production of various types and sizes of boilers and exclusively in building low pressure steam and hot water boilers, water heaters and incinerators.

This boiler firm early recognized the economy and other features of oxy-acetylene welded construction. One of the first things he did before adapting the oxy-acetylene process to production was to construct entirely by welding a test section (shown in Fig. 5) which he turned over to a prominent physical testing laboratory to be tested in the severest manner possible. The results thoroughly convinced him that an oxy-acetylene welded joint was sufficiently strong and tight and he knew from available data that welding was more economical than riveted construction by a wide margin. The section was subjected to 3,500 pounds hydrostatic pressure, without giving the slightest indication of a leak or weakness.

Welded Steel Boilers

Quite as much has been accomplished by this manufacturer in the fabrication of welded steel boilers as other manufacturers have accomplished with all oxy-acetylene welded steel hot air furnaces. In both cases welded construction has made possible the elimination of riveted seams and cast iron sections and thus the objectionable features attendant to their use.

In comparison with cast iron sectional types the welded boiler has a uniform thickness of metal throughout—which is seldom found in cast iron sections. There are no parts liable to crack, or to collect soot and dirt on ledges or open

Fig 2.—Cutting out Burned Section of Scotch Marine Boiler Furnace

spaces between sections to result in low heat efficiency. Leakage is the worst disadvantage of riveted seams in this type boiler. The oxy-acetylene welded boiler is like one solid piece of steel plate and as such leakproof. Welded construction also makes possible a larger amount of direct heating surface.

Not only has the oxy-acetylene process enabled this manufacturer to build a high class product, but it has reduced his production costs by simplifying methods and saving material. It has enabled him to build a boiler which saves his customers money on account of increased fuel economy and lower installation expense.

Minnesota Firm Utilizes Process

A boiler and tank manufacturing company in Minnesota also produces upright and horizontal boilers, several types of storage and pressure tanks, and various specialties in which welding is extensively employed.

The company has adapted welding to the fabrication of

Fig. 3.—All Welded Oil and Liquid Storage Tanks of 1,000 Gallons Capacity

the firebox door of one type of upright boiler, with especially striking results. The old method was to flange the firebox plate outward to meet the outside plate of the boiler and then to lap and rivet the two together to form the firebox door.

The present method is to flange the firebox plate in the same way as formerly, but in addition to bend its edges around and over the outside plate. The bent-over edges of the firebox plate are then welded to the outside plate.

A trial boiler, made of 5/16 inch plate fabricated in this way, was tested under 150 pounds cold water pressure, and approved by the boiler inspectors in the district. There was not the slightest indication of leakage or weakness.

Besides increasing the durability of the firebox door, oxy-acetylene welding has cut the cost of this joining operation at least 50 percent. The company now welds practically all the firebox doors in this way.

Water Tank Fabrication

High-pressure water tanks manufactured by this company are partly riveted and partly welded. Fig. 10 shows a tank of this type. In this tank the side seams are welded, and all the connections (consisting of 4 nipples varying from 1 inch to 3 inches in diameter) are joined to the body by welding

In another type the top plate is also welded to the side plate. The bottom plate is riveted instead of welded in order to permit removing the plate, if necessary to clean the inside of the tank or to repair the coils. This tank is subjected to a working pressure of 100 pounds and requires about 22 linear feet of welding. Another type of tank built in this

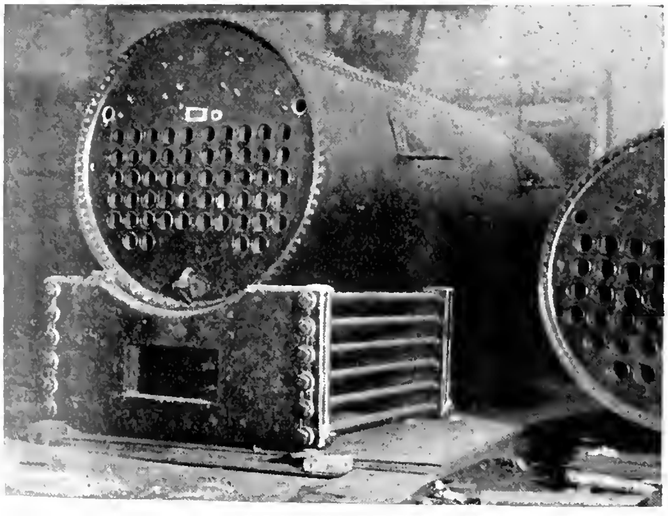


Fig. 4.—Welding was Used Extensively in Building This Unit

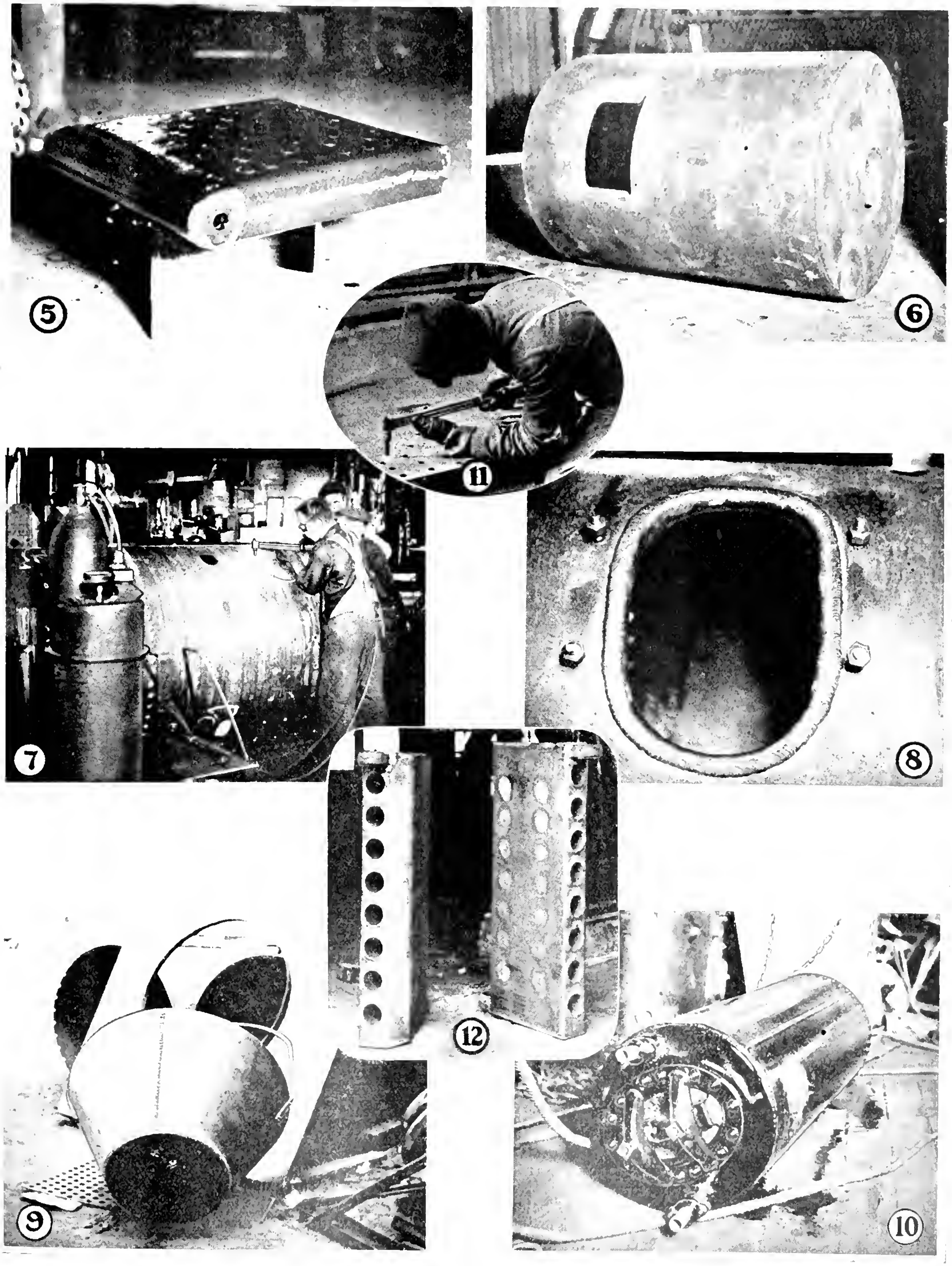


Fig. 5.—Welded Test Section. Fig. 6.—A Type of All Welded Low Pressure Boiler. Fig. 7.—Cutting the Fire Door. Fig. 8.—Close-up View of Welded Fire Door. Fig. 9.—All Welded Cooking Kettle. Fig. 10.—High Pressure Storage Tank. Fig. 11.—Cutting Boiler Plate. Fig. 12.—Welded Smoke Consumers.

Fig. 13.—Cutting off Staybolts

plant has a capacity of 300 gallons, and requires approximately 16 linear feet of welding, including the side seams and connections.

Materials Used

All storage tanks produced by this company are entirely oxy-acetylene welded. These tanks are adaptable to all liquid storage purposes. Some of them are 7 feet long and 5 feet in diameter, are built of 8-gage sheets, and have a capacity of 1,000 gallons. Each tank of this type has about 64 linear feet of welding, including side seam, a circular seam on the side-center, and two circular seams joining the top and bottom to the side plate.

The company manufactures several designs of oil tanks, divided into compartments, for use on wagons or trucks. These tanks are also all-welded, the compartment partitions as well as the tank body sheets being joined by oxy-acetylene welding.

Oxy-acetylene welding is extensively applied in the fabrication of various metal specialties, which form a considerable part of the total production of this company and other boiler concerns. One of these specialties is a cooking kettle for frying potato chips in deep grease, on a quantity basis. The kettle is 20 inches deep and 18 inches in diameter at the top and is made of 1/8-inch steel sheet. It is butt-welded throughout, and has about 140 linear inches of welding.

Pile caps and connections, made of 1½-inch steel, and used by contractors for capping and joining wood piles are also welded. Formerly these caps and connections were riveted, but the projecting rivet heads and the overlap of the joints were objectionable when sinking the piles into the ground, sometimes even splitting them. Welding eliminates these undesirable features and cuts in half the former cost of producing the caps and connections.

The oxy-acetylene cutting blowpipe is used largely by this company, especially for cutting odd-shaped metal pieces and for making openings in boilers and tanks.

This company has used the oxy-acetylene process for many years, and has kept comparative production cost records over considerable periods to determine the relative cost of welding and riveting, and of oxy-acetylene cutting and other methods of cutting. The result is that oxy-acetylene welding and cutting have become general practice at this plant, wherever they are adaptable. Oxy-acetylene welding or cutting is applied in some way on almost every product manufactured by the company.

Welding Widely Used in Boiler Repair Work

Leaving the field of small boiler and tank work, the process has wide application in boiler repairs, both for cutting out sections of burned or corroded material that can be safely replaced by a welded patch and for building up metal that is still sufficiently strong to carry the working load, but does require a given thickness for proper fitting of parts.

As previously mentioned this latter use of welding is often effective where slight errors are made in the fabrication of plates that in no way endanger the structure but which can advantageously be corrected by the judicious use of welding. It is understood under the present status of the process that welding can only be used in high pressure boilers where the stress is carried by other parts of the structure than those which have been welded. In this work it is supplementary and adds both strength and tightness.

In the matter of salvaging plates by welding, however, it is unquestionably the shop inspector's duty and that of the state and district inspector to use his judgment and experience in such matters to determine whether the material has been weakened, beyond the point of safety, before the welding is applied. If such is the case, naturally the use of the process is not advisable. Incidentally many of the instances of pressure vessel failures on record, contributed to in violence by the failure of welded seams, might be traced to the careless use of the process in covering up defects or carelessness in workmanship.

Since the reputation and future of autogenous welding depend on the success of every single application, the workmanship must be above reproach and a torch never allowed in the hands of an unskilled or careless operator.

Fig. 14.—Welding a Patch on a Firebox Type Boiler

Marine Boiler Construction and Repair

For Scotch marine boiler work, welding has assumed a rather important part. Certain of the large shipyard boiler shops have been utilizing the process wherever possible in turning out boilers for sea service which oftentimes is very severe and proper maintenance is out of the question except at long intervals. In one case, for example, seams and stay nuts in the combustion chambers are welded up to a point 2 feet above the center line of the furnace. The inside butt straps are beveled down on the ends to the thickness of the boiler head flanges and welded across the ends at that point and for a distance of 6 inches along the head flange and the same distance along the butt straps from the flange. Where the shell plates butt together they are beveled and welded for a distance of 12 inches from each end. The saddle lugs, which are fitted with a ¼-inch calking strip, as indicated before, are welded on the inside of the lugs to the shell.

Welded Seams

All seams of the combustion chambers in contact with flame are welded inside and out to protect the edges of the plates and insure against any possible leaks. This welding is carried to a point 2 feet above the center line of the furnaces. All screw stays up to a point 2 feet above the center line of the furnaces are fitted with special round collar nuts which are welded after being screwed on the stays.

Work of the A. S. M. E. Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the council of the Society for approval, and then given publicity where it will reach the members of the industry who are interested.

Below are given the interpretations of the committee in Cases No. 412-417, inclusive, as formulated at the meeting of March 22, 1923, and approved by the council. In accordance with the committee's practice, the names of inquirers have been omitted.

Case No. 412—*Inquiry*: Is it permissible, under the Code, to use on boilers, pressed-steel nozzles having the upper or bolting flange of the Vanstone joint construction, with the bolt-flange made of steel?

Reply: While the form of construction proposed for a boiler nozzle embodying the use of the Vanstone joint, as outlined, does not conflict with the requirements of the Code, provided the flange, dimensions, etc., meet the requirements of the Code for pipe flanges, it is the opinion of the Boiler Code Committee that a rigidly attached form of nozzle flange is preferable.

Case No. 413—*Inquiry*: What is the permissible stress for screwed stays with ends riveted over less than 20 diameters in length, when such screwed stays are inserted in the sheets at an angle that is not truly radial in the case of curved plates, or in the case of flat plates is not normal to the plane of the plate?

Reply: It is impossible to formulate any logical requirement for a condition of that sort and it must be a matter of judgment. A revision of the Code has been proposed which reads as follows:

"All staybolts not normal to the stayed surface shall have not less than three engaging threads, of which at least one shall be a full thread."

The angularity in such case should not exceed 15 degrees to the stayed sheet. If the angularity is greater than 15 degrees it must be taken into account in calculating the permissible stress in the staybolt.

Case No. 415—*Inquiry*: Where a boiler of the locomotive type is fitted with a form of removable drum, attached by bolted connection to the outlet nozzle, as is customary practice in the California oil fields, is it the intent of the Code that the requirements of Par. 194 shall apply to the construction of the drum, or can this construction be considered as a steam drum subject to the requirements of Par. 187?

Reply: It is the opinion of the Boiler Code Committee that the form of construction shown is not a boiler dome and therefore does not come under the requirements of Par. 194 of the Code, but must be considered as a steam boiler drum coming under the provisions of Pars. 187 and 188

Case No. 417—*Inquiry*: Is it the intent of the Code to require any particular design for suspension lugs to support horizontal-return-tubular boilers 78 inches or less in diameter?

Reply: It is the opinion of the committee that it was not the intent of the Code to require any particular design for suspension lugs to support horizontal return-tubular boilers 78 inches or less in diameter, but that any such lugs should conform to the requirements of Pars. 324 and 325 of the Code.

Case No. 414—*Inquiry*: Is it permissible, in the case of the flue of an internally-fired boiler which is corrugated for about half of its length and the remainder plain, to calculate the thickness of the plain portion in accordance with Par. 239, assuming that the length of the plain portion is the distance from the center line of the rivets in the head to the beginning of the corrugations?

Reply: It is the opinion of the Committee that in the calculation of the thickness of the plain portion of such a furnace, Par. 239*b* should be used, taking for the length the distance from the face of the flange to the center of the first definite corrugation, and the thickness thus obtained shall be uniform throughout the entire length of the flue.

Case No. 416—(In the hands of the Committee).

Case No. 418—*Inquiry*: Is it permissible under the requirements of the Heating Boiler Section of the Code, to attach the safety valve to the pipe-header outlet connection of a type of cast-iron sectional heating boiler with sections designed too narrow to admit of a separate opening on any one of them for the safety valve?

Reply: If the design of the boiler is such that it is not possible to form the safety-valve openings directly on the boiler sections, it is the opinion of the Committee that the sections should be connected at two or more points to a manifold or header which will serve as a steam drum, and that it will be permissible to mount the safety valve on this manifold or header.

Case No. 419—(In the hands of the Committee).

Case No. 420—*Inquiry*: Is it permissible, under the requirements of the Boiler Code, to drive up a blister or blisters on a tube or tubes of a watertube boiler and reinforce them by depositing metal over the same by the autogenous process; or later when other blisters appear above or below the first reinforcement to again use the same process, increasing the length of the reinforcement; also to weld tubes lengthwise by the same process regardless of minimum or maximum length of weld for any thickness of tube and for any pressure without removing the tube from boiler or annealing the welding?

Reply: It is the opinion of the Committee that such reinforcement or welding of blisters or other defects in the tubes of watertube boilers would be analogous to the welding of cracks in shell plates subject to tensile strain which is prohibited under the Recommendations for Repairs by Welding in the Appendix of the 1918 Edition of the Code, page 127, third paragraph.

Home-made Appliances for Boiler Shops

Structural Details of Equipment That Can Be Easily Assembled with Practical Applications of the Devices

By James F. Hobart

A FEW years ago I became interested in copying all the shop notices that were found in various shops visited, but about five or six years ago, the habit was abandoned. It was brought straight home to me that the average shop notice is not worth the paper it is printed on. Or, in other words, "not worth the powder to blow it to * * *!"

It was in the Big Four Railroad Boiler Shop at (Maple Grove) Indianapolis, Indiana, and I was reading a notice posted conspicuously beside a big grinding machine. Two pairs of stout goggles hung from a nail just under the notice, which was as follows:—

> NOTICE—Any employee using this machine without goggles will be discharged. This will be enforced.

While I was reading, a man came and ground a tool on the machine, but he did not put on the goggles. In fact, he never even looked at them! The incident brought to mind the saying of an old shop foreman:—"It's easy to write notices, but it's a big job to enforce them."

Only a short time afterwards, I encountered another shop sign which killed all desire to add any more to my collection. This one was in a wash room where the foreman had evidently been unable to keep some of his men up to the required sanitary conditions. In despair, he had a sign made and posted to the effect that:—

"If you can't read, get to———out of here!"

That notice capped the climax and the writer has added no more to his collection. It is all well and good to post notices on the shop bulletin board. Such posted notices are pretty sure to be read and if anything posted there is of interest to the workmen, they will heed the notice. But nine times out of ten, the effort is time, ink and paper wasted.

Air-Posts and Rivet-Trucks

Here are a couple of kinks which were found in the boiler shop of the Lancaster (Pa.) Iron Works. They have a fine shop with concrete and dirt floors, and with the roof-supporting posts each set a couple of feet above the floor, upon square concrete piers. Around the top of each post pier or footing *C*, has been placed a frame *B*, as shown in Fig. 1. From four to six compressed air connections are to be found at each post as shown at *A*, *A*, *A*, the connections project through the frame just far enough for the men to connect on air hose to one or more as required. The air pipe as shown, comes down the post, and the valves which control the several air outlets, are all located inside of the frame, where they are well protected from accidental injury.

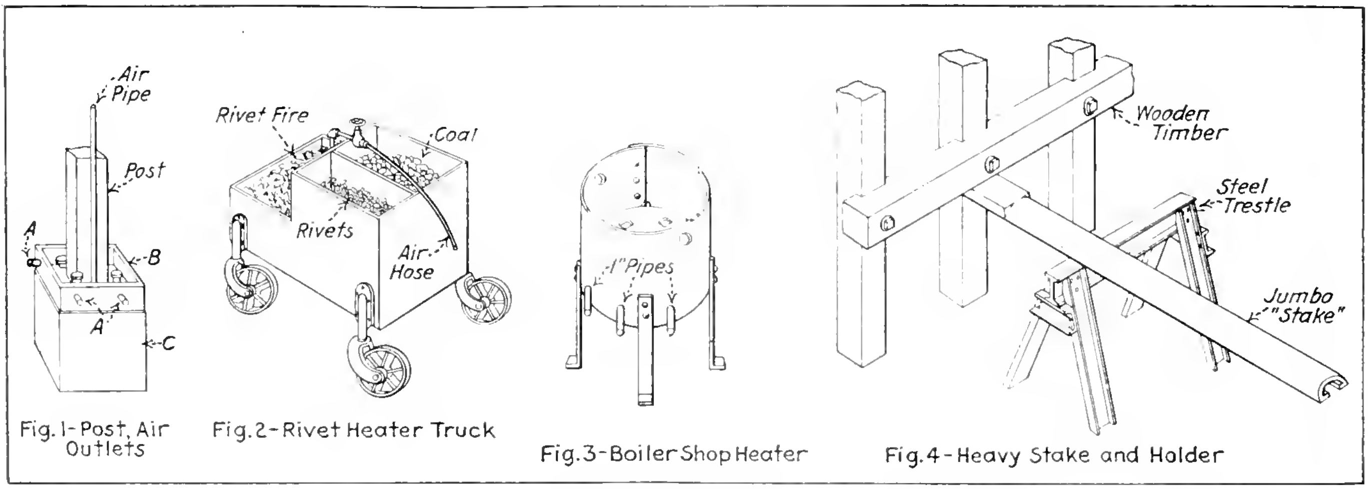


Fig. 1-Post, Air Outlets Fig. 2-Rivet Heater Truck Fig. 3-Boiler Shop Heater Fig. 4-Heavy Stake and Holder

Easily Made Equipment That Will Help Out Production

In the same shop, I saw in use a rivet heater which was fastened upon a truck, or rather, what answered for one. Four big casters attached to the device, as pictured by Fig. 2, permitted the heater to be pushed almost anywhere, even where floor-room was quite limited.

The device was built of heavy tank steel and as shown it contains three compartments, one full of dirt, where the rivet fire is kindled and kept going by a blast from the air-hose on top of the heater. The two other compartments are—a large one for coal and a smaller one for rivets. This makes the appliance pretty well self contained. Mounted on the big casters, it can be moved easily and quickly, and even spun around "in its tracks" with little trouble or loss of time.

I have not shown the manner in which that rivet-truck was put together for I wanted you to have an open mind when you make one for your shop. Then you can, if you wish, flange and rivet the plates together. Or, you can rivet each one to corner angles. But, before you select either of the above noted ways, just consider making up the truck with an oxy-acetylene welding torch, thereby making a truck as smooth and clean-looking as the one shown by Fig. 2.

It is not very seasonable, just at this time of the year, to lug in a shop heater, but here's one which is so mighty simple that I wish you would take a look at it as pictured by Fig. 3. We wont start a fire in it just yet, but give it the "once over" and note that it is made from a bit of tank steel, or a piece of plate from some old boiler. There are four legs riveted on, holes made for three pieces of one-inch pipe, and a loosely fitting bottom plate has three rough holes in it. The holes in the sides, near the upper edge, are for attaching hooks of a chain suspended from the shop crane. In this manner, the heater may be quickly moved from place to place even while the fire therein is burning briskly.

When a new fire is to be lighted, pulling out the three pieces of pipe will dump the old fire and leave the heater clear and clean. Replace the short bits of pipe, drop the perforated bottom plate in place and the heater is ready for the new fire. When the fire burns too fiercely—something that hardly ever happens in a chilly boiler shop—a bit of steel plate on top of the heater controls the fire to a nicety and is much appreciated at noontime by the workmen, for heating their dinner-bucket coffee-cans.

Boiler-Shop Stake-Holder

A big "stake" similar to the kind used by tinners and sheet metal workers, is a mighty handy thing to have in a boiler shop, even if it is necessary to improvise a stake by making a hitch with the shop crane around a length of railroad iron, lifting it level, with the far end on a barrel and then using the end of the rail as a stake where it overhangs the crane

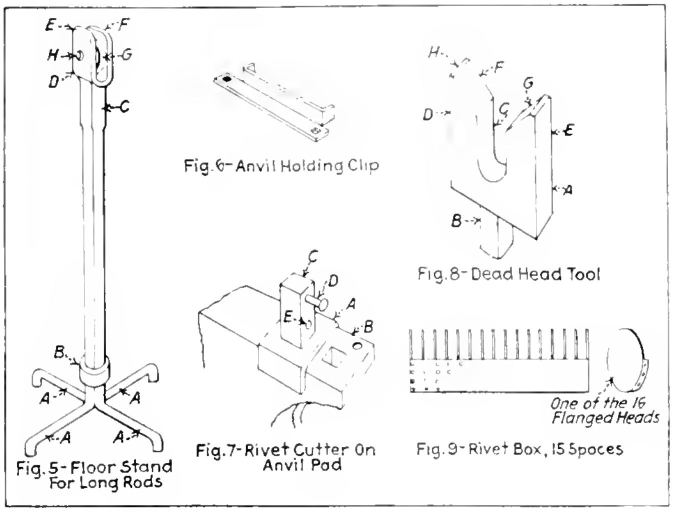


Fig. 5-Floor Stand For Long Rods
Fig. 6-Anvil Holding Clip
Fig. 7-Rivet Cutter On Anvil Pad
Fig. 8-Dead Head Tool
Fig. 9-Rivet Box, 15 Spaces

Anvil Attachments and Other Convenient Devices

fastening. That scheme works well, all right, but it is not quite as handy as a stake arrangement in use in the "T. & P." shops, New Orleans, La.

Such a "Jumbo" stake and a permanent built-in stake-holder is shown in Fig. 4. This stake is a huge affair ten feet long, or so, made like the one used by tinners, only larger. A bit of railroad iron, a piece of shaft or even a narrow floor-plate can usually be found doing duty as a stake, the permanent fastening therefor, permitting the use of almost any kind of a stake, from a bit of timber to the fine stake shown by Fig. 4. This engraving shows one end of the stake resting underneath a timber which has been permanently framed into the timber work of the building. The free or work end of the stake hangs over a stout steel trestle or "horse," made expressly for the purpose, with a stiff I-beam backbone, capable of supporting almost any load likely to be placed upon the stake. Do not make the mistake of placing a steel beam in the building to hold down the back end of a stake, as shown. Steel used thus is too noisy, and even a boiler maker sometimes finds it pleasanter to his ears with a bit of board interposed between the trestle and the stake—it makes far less noise, thus.

A Trolley Floor Stand

The New Orleans "T. & P." shops have also the appliances shown by Figs. 5, 6, 7 and 8. When long rods have to be worked, either in the forge shop or while being threaded and cut off, an appliance which will support the far end of the long rod is often badly needed. Such a rig, and a mighty neat one too, is shown by Fig. 5. It was made from four lengths of round black steel, the ends *A*, *A*, turned out and down four feet, after the other ends of the four rods had been securely fastened together by a shrunk-on band *B*, and then welded solid into a head *C*, which was later split as shown at *D*, and forged into jaws *E* and *F* to receive sheave *G*, which in turn was fastened by pin *H*.

No attempt was made to have this stand adjustable in height. It was made just high enough for the work it was to do, and fixed that way, for good. The top ends of jaws *E* and *F* were rounded off, and also beveled sidewise so that should a rod happen to strike on top of the jaws, it would slide off upon the sheave, rather than off the stand altogether.

Some Anvil Tools

Several rigs and jigs for use on anvils in the boiler shop of this railroad are shown in Figs. 6, 7 and 8. A stout bit of boiler plate, two bits, in fact, were sheared long and narrow as shown by Fig. 6, then flanged lengthwise in the middle, square spike holes punched as shown, then the ends were bent inward as shown, and hammered snugly down against the base of a big anvil. A strip was placed at either end of the anvil and, after having been forged snugly against it, railroad spikes were driven through the square holes in both straps, fastening them and the anvil securely to the anvil block.

The value of these clips became apparent whenever the anvil happened to get upset, as the block remained right in place, where it belonged. Also, when the anvil was moved around the shop by the overhead crane, it never parted company with the block, but a hitch from the crane-chain, took both along together.

Rivet-Cutter and Anvil "Dolly"

A four-inch square bit of steel six or seven inches long was shouldered at one end and riveted into or welded upon a strip of heavy boiler plate as shown at *A* and *C*, Fig. 7. Then the ends of the plate strip were bent downward so as to slide easily along on top of anvil *B*.

Holes of several sizes were drilled in the sides of the steel post as shown at *D* and *E*. The top of the post formed a dandy place for driving small rivets in flat work and when a rivet was too long, it could be inserted as shown at *D*, in the proper size of hole, and a stroke from a sledge, against a handled cold chisel, quickly cut the rivet off flush with side of the post. The smith also found this device handy when forging small articles and needed a square corner sharper than could be found on the shop anvil.

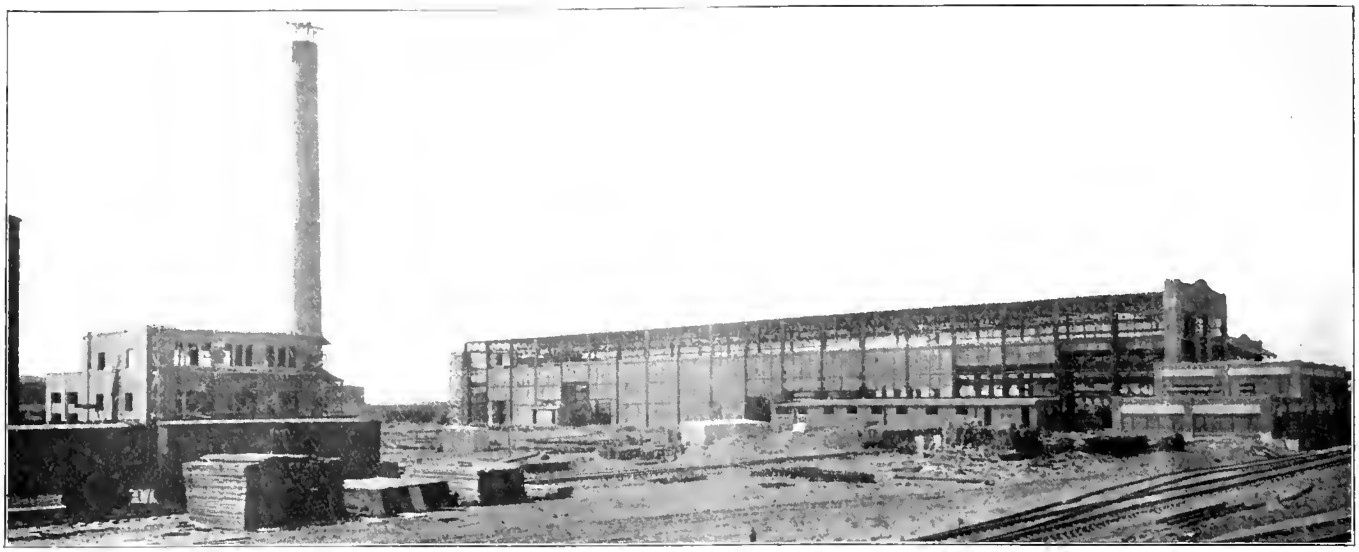
"Buck-Horn" and Bending Tool

A very handy anvil tool of the "deadhead" class was made by slotting a stout piece of tool steel as shown by Fig. 8 at *C*. Then the lower end of the steel was shouldered down to fit the hardy-hole of the anvil. Later, the sides of the tool, *D* and *E*, were beveled back as shown at *F* and *G*, until only a narrow flat end was left on each side, as shown at *H*.

This tool found a great variety of uses. When small rods or straps had to be bent, one of them would be placed between jaws *D* and *E*, in slot *C*, and by "taking a pry" on end of the piece and properly reinforcing with sundry hammer blows, the piece would be bent easily and quickly, without having to go to a vise with the work.

Steel Rivet Boxes

Down in Memphis, Tennessee, in the I. C. boiler shop, I saw a mighty convenient receptacle for keeping rivets safe, and handy at all times. What is more, all kinds of rivets used in the shop were kept in a couple of these boxes which, as shown by Fig. 9, were made from boiler plate and contained from eleven to fifteen compartments each.



The New Shop as Seen from the Southeast

Repair Shop Has All Facilities Under One Roof

New "Katy" Plant Accommodates Erecting, Machine Tools, Boiler and Tank Work and Stores in One Building

THE comprehensive program for the improvement of facilities for the handling and repairing of locomotives which has been carried out on the Missouri-Kansas-Texas, under the receivership recently terminated, includes the construction of a locomotive repair shop at Bellmead terminal, Waco, Tex., at a cost of about $1,700,000, which is designed for the conduct of all classes of heavy locomotive repairs. In addition to the large repair shop building, which is of particular interest because it houses all the necessary facilities for the conduct of locomotive and boiler repairs under one roof, the improvement includes a number of auxiliary facilities, of which the most important is a large modern power house. The new facilities have been designed to fit into the existing layout at Bellmead, making such rearrangements as were found necessary, including certain changes in track locations. It was necessary, however, to make some additions to the land area devoted to terminal purposes at this point.

The present construction is planned for heavy repairs to 16 to 20 locomotives per month and, while the shop is designed primarily with a view to economical operation under present conditions, consideration was also being given to its adaptation to a plan for future development with a minimum expense for rearranging buildings and tracks.

Boiler Shop Arrangement

The main portion of the shop building is 475 feet long by 151 feet wide, measured inside the walls, and is subdivided into 19 transverse bays 25 feet wide, and 2 aisles or longitudinal bays, 80 feet and 71 feet wide respectively. A second aisle 71 feet wide forms a wing for a length of 8 bays or 200 feet along the north side of the building at the west end, while at the east end of the building is another wing, 152 feet, by 50 feet projecting south from the south side of the building for a distance of 74 feet 2¼ inches. Also along the south side of the building are two smaller wings, one 25 feet by 150 feet and the other 25 feet square, while another small wing, 27 feet by 58 feet 8 inches projects from the north side of the building.

The 80-foot aisle in the main body of the building comprises the erecting shop, while the 71-foot aisle serves as the machine tool shop. However, the first four bays of these two aisles at the west end of the building, covering an area 100 feet by 151 feet, will be utilized as a boiler shop while the remaining 375 feet of these two aisles will serve as the locomotive shop. The large wing projecting from the north side of the building will be the tank and plate shop. The east bay, which is a two-story structure, will house the stores department on the lower floor, and the shop office and manufacturing toolroom on the second floor. The two small one-story bays along the south end of the building will house locker and toilet rooms for white and colored employees and two fan rooms, while the small wing on the north side of the building will be used as a distributing toolroom and foreman's office.

The building is of steel frame construction throughout with the major portion conforming to the prevailing standards of industrial building construction. The erecting aisle has a clear height of 53 feet 1 inch to under-clearance of the roof trusses which are supported on columns conforming to the 25-foot transverse bay arrangement and designed to support the roof trusses and two crane runways, the upper one for a 180-ton crane to handle locomotives and the lower one for a 15-ton crane to be used in handling lighter parts. As it is believed that the 180-ton crane can readily handle all movements of locomotives to and from the various pit tracks, it has been deemed unnecessary to provide a transfer table. Each of the 15 bays in that portion of the erecting aisle to be used for the locomotive erecting shop is to be equipped with a track and track pit each track extending a distance of eight feet into the machine tool aisle.

The two 71-foot aisles are of duplicate construction except that the one used for the tank and plate shop does not extend the full length of the building. The underside of the roof trusses in these two aisles is 35 feet 7 inches above the floor, and each is equipped with a crane runway with top of rail 26 feet 4 inches above the floor. The crane in the machinery aisle is to be of 15 tons capacity, while that in the tank and plate shop aisle is of 40 tons capacity. The roof trusses in each case are of rectangular outline except that a single saw tooth is superimposed on each with its top extending to a height of 16 feet above the general level of the roof and providing a window area having a vertical height of about 12 feet.

An interesting detail in connection with the efficient operation of the machine shop is to be found in the extension of the crane runway for the machine tool shop for a distance of 75 feet beyond the east end of the building, or over a casting platform and the tracks adjoining it so that the crane can be used for unloading castings or in transporting them from cars or the platform to any of the machine tools in the shop.

The shop floor is of reinforced concrete, with a mastic surface, while the roof consists of cement tile, covered with composition roofing. The walls of the building are almost entirely glass. Along the two sides of the main shop structure, the glass extends for the full width between the faces of columns which are exposed at the outside of the building. The two ends of the shop are also largely of glass, except that ornamental treatment is provided in the form of brick pilasters, and brick facing in the plane of the trusses. The brick work is ornamented with concrete belt courses and copings. The glass areas in the smaller wings and in the portion of the building used by the store department and the manufacturing tool room is also large but with considerable area in brick pilasters and concrete trim. All glass throughout the entire building is set in steel sash.

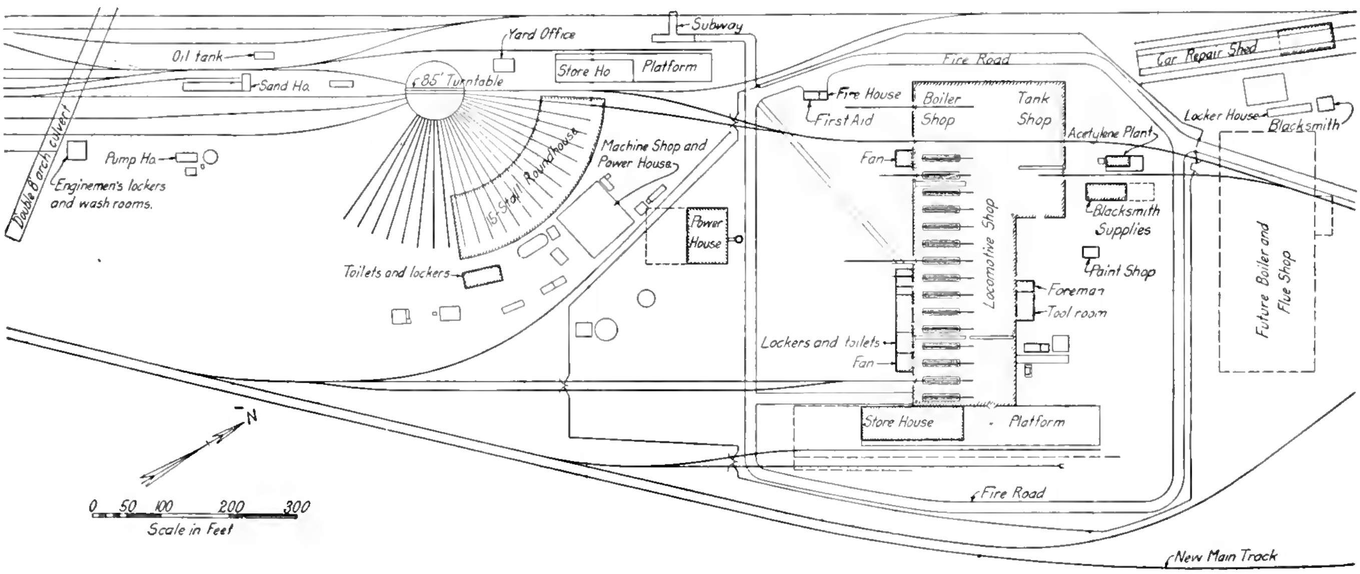
The building is heated throughout by a forced draft hot air system from the two fan rooms mentioned above where air driven through steam coil heating units is transmitted through concrete ducts under the floor to outlets distributed throughout the building.

The brick and steel power house is located between the shop and roundhouse. The present construction is designed for the use of oil as fuel, with provision for the installation of coal and ash handling facilities when required. The reinforced concrete chimney is 8 feet in diameter, and 177 feet high. The power installation includes 328 horsepower water-tube boilers and appurtenances, two air compressors of 2,000 and 500 cubic feet capacity, and duplicate fire pumps.

The shop is completely equipped with new machinery, driven by electric power with individual motors. The circuits are generally carried in conduits under the floor. A circuit with self-registering apparatus is provided for checking machine performances. Electric power is furnished from the Waco station of the Texas Power and Light Company.

Among minor outbuildings are a supply building for the blacksmith and boiler shops, a paint shop, an oxy-acetylene plant, a first-aid room, and a fire engine and hose house. The work under way also includes a brick lavatory and locker building for roundhouse employees. A concrete subway 8 feet by 8 feet, 355 feet long has been constructed under the yard.

The preparation of the site involved 140,000 cubic yards of grading and the relocation of a mile of main track. The work includes about 3,300 cubic yards of reinforced concrete in culverts, subway and foundations and 2,000 tons of steel.



Map of the Facilities at Bellmead Terminal. New Structures Indicated by Heavy Lines

Comparison of Tool Steels

An important method of comparing tool steels is known as the lathe breakdown test. In this test the tool is used for cutting into a steel of definite composition, and works at a known speed and rate of cutting until it is worn out. A report on such tests has been issued by the Bureau of Standards telling of the results of such tests on various kinds of modern tool steels and discussing the limitations of this method when applied to the purchase of steel. The conclusions drawn are summarized as follows:

1. Breakdown tests are not satisfactory as a basis for the purchase of high-speed tool steels.

2. Competitive comparisons of brands having nearly similar performance is not justified, owing to the qualitative nature of this type of test; but relatively large differences may be determined.

3. Certain severe breakdown tests were made with roughing tools on three percent nickel steel forgings, and in them high frictional temperatures were produced. In these it was found that the performance of commercial low tungsten, high vanadium and cobalt steels was superior to that of the high tungsten, low vanadium type of and special steels containing about one-fourth percent uranium and three-fourths per cent of molybdenum.

4. Modification of the test conditions, including small changes in tool angles, but principally changes in cutting speed, had a more marked effect on the performance of steels containing cobalt or special elements, such as uranium or molybdenum than it did on that of the basic types.

5. The high tungsten steels showed relatively poor endurance under severe working conditions, but did much better in more moderate tests. The latter were made on the same test log and with equal cutting speed and depth of cut, but with reduced feed. The frictional temperatures were not so high.

6. Hardness determinations and examinations of fractures indicate that the various types of commercial high speed steel show differences in behavior under heat treatment and in physical properties which are of importance under moderate working conditions and might counterbalance slight advantages in performance.

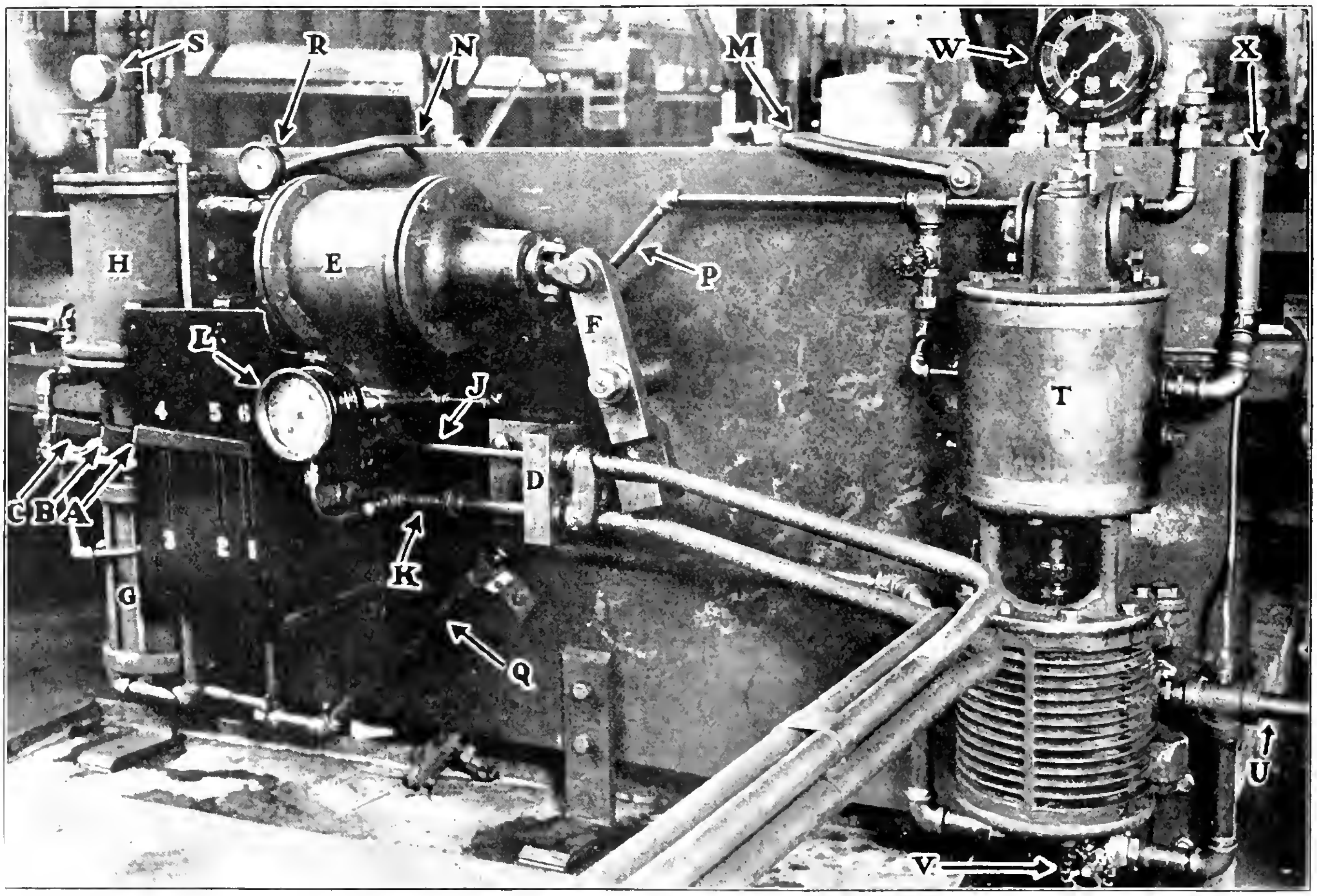
Device for Testing Superheater Units and Air Reservoirs

Speed in Operating and Accuracy and Severity of Testing, Features of New Device

ONE of the most simple and efficient devices yet developed for testing superheater units and air reservoirs is shown below. It was designed and constructed for use in the Readville shops of the New York, New Haven & Hartford.

As shown, the operating mechanism is mounted on a large steel back plate 1 inch thick, supported on the bottom by three right-angle legs with holes drilled to provide for bolting to the floor. The rugged design of the testing device throughout is evident from the illustration. Moreover it is a compact unit which can be readily moved to the most convenient place in the shop by means of a crane and chain hooks attached to the hangers *M* and *N*. At the time of taking the photograph the tester was not in its final location and it has since been moved to the erecting shop where superheater units can be handled to and from the device with the minimum effort.

Referring to the illustration, a superheater unit is shown applied to two false seats in the substantial angle block *D* rigidly bolted to the back-plate. In testing, the unit is held with a heavy pressure against block *D* by means of lever *F*, pivoted as shown and operated from brake cylinder *E*. The final test pressure on the unit is obtained by hydraulic pressure from cylinder *G* direct-connected to brake cylinder *H* by means of a piston rod. The piston in *H* is operated by shop air pressure at 80 pounds from a one-half inch pipe, the pressure being shown by gage *S*. The unit is filled and tested through pipe *J*, being blown out through pipe *K* which is connected through a suitable valve to the exhaust, not shown. The test pressure on the unit is indicated by gage *L*, being between 400 and 500 pounds. Shop air pressure at 80 pounds is provided in pipe *P*, the connections being such that this pressure is shown by gage *R*. City water at a pressure of 40 to 50 pounds is provided to pipe *Q* and used for filling the units and hydraulic cylinder *G*.



A Compact and Efficient Device for Testing Superheater Units at the Readville Shops of the New York, New Haven & Hartford

This tester is operated by means of three levers *A*, *B* and *C*, each of which has two positions and is interlocked with two three-way valves. Three levers are required, for the reason that there are three main pipe connections, namely city water, high pressure water and air required in blowing out units. The arrangement of the interlocking levers to the six valves is extremely ingenious and foolproof, making it impossible to perform the various operations out of their proper order. Moving handle *A* to position *1* supplies air to brake cylinder *E*, clamping the unit quickly and with a heavy pressure which practically eliminates all chance of leakage at the two joints. Handle *B* is moved to position *2* allowing water at street pressure to fill the unit and cylinder *G*. Moving handle

C to position 3 shuts off the water supply and admits air on top of the piston in cylinder *H* applying hydraulic pressure to the unit. Moving handle *C* back to position 4 exhausts the air in cylinder *H* and closes the connection from cylinder *G* to the unit. The unit is opened to the atmosphere and water and scale blown out by shop air pressure when handle *B* is moved to position 5. Moving handle *A* to position 6 shuts off air pressure to the unit and releases the air in cylinder *E*, also releasing the unit.

All of the above operations take far longer to describe than to perform. In fact, a unit can be applied on this device, tested and released in a fraction of a minute. Not only is the operation speeded up but the test is much more thorough and severe than that ordinarily accorded superheater units. Cylinder *G* is bushed so that a pressure of 400 to 500 pounds is obtained quickly showing up any defects which exist. This allows defects to be corrected before the units are reapplied and perhaps cause service failures.

Testing Reservoirs

Air reservoirs are tested by means of the Westinghouse 9½-inch air compressor *T* which is bushed on the air end to boost the shop pressure to at least 225 pounds, at which the reservoirs are tested. Pipe *U* is connected to the reservoir (not shown in the illustration), and in operation valve *V* is opened allowing water to practically fill the tank. Valve *V* is then closed and the air compressor started increasing the pressure on the reservoir to 225 pounds when the standard hammer test is given. The test pressure is indicated by gage *W*, connected by a copper pipe to the tee at the air discharge as shown. Pipe *X* is the exhaust from the air compressor.

Making a Long Radius Arc

By Phil Nesser

OFTENTIMES we come across a job in the layout of boilers or steel work, where it is necessary to lay out an arc of such radius that our tools will not reach the center of the arc; for this, the writer wishes to suggest the following method:

Suppose we start with a small circle, reasoning that in Fig. 1 the dimension *A* multiplied by the dimension *B* will equal the square of the dimension *C*. Expressing this in a formula, we have *C* squared equal to *A* times *B* or $C^2 = AB$. And *C* is the square root of the product of *A* times *B*.

The dimension *A* in Fig. 1 is the height of the segment of the arc, of which two times *C* is the length of the chord, and *A* plus *B* equals the diameter of the circle. The radius would then be the sum of *A* plus *B* divided by two.

In large arcs the dimension *D*, Fig. 1, is so near one-fourth of the dimension *A* that it can be used as such for all practical work and give as close results as we are able to measure without getting into hundredths of an inch, that is, if the arc is over ten feet radius. For less than that we could use the trammels. Also we must not take too much of the circle into the arc, say, not over 30 degrees on the arc, and the method here given will work out.

Considering that the diameter is twice the radius of the circle, then the radius is always the sum of *A* plus *B* divided by two. Assume that we have to draw an arc of which the radius is to be 200 inches, the diameter would be 400 inches. If the dimension *A* equals one inch, *B* must then be 400 minus one inch or *B* is 399 inches. Considering that *C* in Fig. 1 is the square root of the product of *A* times *B*, we can see that the length of half the chord would be the square root of 399 inches.

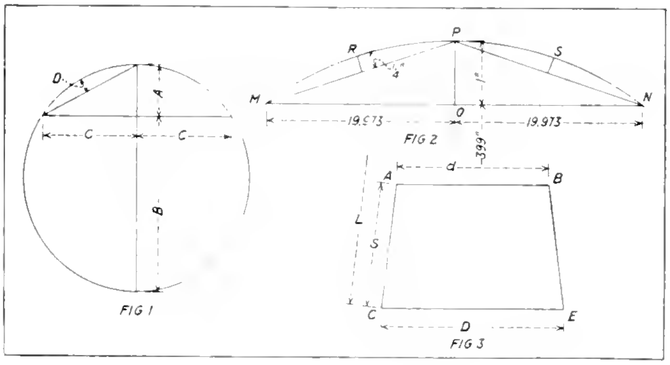
Turning our attention to Fig. 2, the dimensions are marked, one inch in place of the letter *A* as in Fig. 1, and 399 inches for the dimension *B* and the product of *A* times *B* would be 399 inches.

Extracting the square root of 399 need not scare anyone, for we have books with these things all worked out, and we have only to find the table of squares and square roots of numbers that are printed in most all pocket memorandas, or books of mechanics' tables. Several such books are published by the large steel companies and can be secured by corresponding with them, or from any book store.

The square root of 399 is 19.973. This is substituted for *C* in Fig. 1, and marked upon Fig. 2 as the length of half the chord of the arc.

To construct Fig. 2, draw a line of indefinite length as *M-N*. At any point, as *O*, draw the perpendicular line *O-P*, which is to be one inch in length. From the point *O* measure each way 19.973 inches, locating points *M* and *N*. This locates *M*, *P* and *N*. Then draw a line from *M* to *P*. Bisecting this with a perpendicular line one-quarter inch long, locate point *R*. This is repeated on the line *N-P*, locating point *S*. Having located points *M*, *R*, *P*, *S* and *N*, we can trace the arc through these points.

If more points are desired, we could draw chords again connecting each of the located points and setting off from



Long Radius Arc Details

the center of each one-sixteenth of an inch for the heights of the segments of each newly formed chord. The next such subdivision would give only one sixty-fourth of an inch for the heights of the segments of newly formed chords, etc., for each time the chord is divided in two parts, the segment diminishes in height one-fourth.

Recalling a case where this would be of use, Fig. 3 shows the side elevation of a tapered cylinder. *AB* is the small diameter, *CE* is the large diameter. To lay out such cylinder we may not have a chance to use the trammels on account of the extreme length of the dimension *L*, which is the distance, measured along the slant, from the point *C* to where the sloping sides would meet, if continued to a point. The slant height *S*, Fig. 3, multiplied by the large diameter, and this divided by the difference between the two diameters, gives the length of the long radius that it takes to lay out the pattern of the taper cylinder. This, expressed in a formula, is the product of *S* times *D* divided by *D* minus *d* equals

L, or $L = \dfrac{S \times D}{D - d}$, in which *S* is the slant height of any tapered pipe, *D* the large diameter, *d* the small diameter and *L* the length of the long radius in the pattern. As the method of making the pattern has been described so many times before and as the only part the writer wishes to bring out is the method of making a long arc, we will omit the making of the pattern of the tapered cylinder in this article. Suppose we had to make a tapered cylinder with the large end 20 inches diameter, the small end 19 inches diameter and the slant height 10 inches. Substituting these dimensions for the letters in the above formula, we have $L = \frac{10 \times 20}{(20 - 19)}$ and L is found to be 200 inches. The work given in Fig. 2 will explain how to make the arc to get the large end, and by drawing a concentric line 10 inches away toward the center of the arc, taking the lengths of the circumference upon each arc for each respective end we could lay out such a cylinder without making it up to full size outlines, and save the time of making such outlines.

To make the arc after locating points as explained in Fig. 2, we take a steel straight edge about 2 inches wide set on edge and bend it flatways until it passes through the points, taking 3 or 4 points at a time.

Rules for Inspecting Power Boilers

Methods for Making Internal and External Inspections to Determine Fitness of Boilers for Service

The following paragraphs constitute a section of the preliminary report of the A.S.M.E. sub-committee on the operation and care of power boilers—under the Boiler Code Committee. The rules apply only to steam boiler construction in compliance with Part 1, Section 1 of the Boiler Code and to those not subject to federal inspection and control, including marine boilers, boilers of steam locomotives, etc. Complete details of the rules and action taken by the American Society of Mechanical Engineers in the matter can be obtained from the Secretary of the Boiler Code Committee, C. W. Obert, 29 West 39th street, New York, N. Y.

Rules for Inspecting Power Boilers

C-210. All power boilers shall be given two external and one internal inspection per year by the state or municipal inspectors having jurisdiction or by the inspectors of the insurance company carrying the risk. These inspectors are hereinafter termed authorized inspectors.

C-211. Similar inspections shall be made by the person responsible for the boiler plant as a whole, who is hereinafter termed the plant inspector. Such inspections shall be supplementary to and in no wise considered as supplanting or superseding the inspections made by authorized inspectors. Such inspections shall be made in accordance with the following rules:

C-212. Between periodical inspections by authorized inspectors, the plant inspector shall closely observe the operation and condition of the boilers and shall report immediately to the proper authorities any serious defects, doubtful conditions or unusual occurrences.

C-213. An external inspection shall comprehend the superficial examination of the boiler, its appurtenances and connections and does not necessarily require that the boiler be off the line. It is a form of examination to check up care and management mainly.

C-214. The internal inspection of the boiler shall be a comprehensive and thorough examination in every detail, embracing particularly the determination of the suitability of the boiler for load and pressure carried, strength of its parts, possible deterioration in service and advisability of its continuance under the pressure carried previously to inspection.

C-215. No particular preparation shall be necessary for an external inspection other than giving the plant inspector convenient access to the boiler and its connections.

C-216. The internal inspection shall call for somewhat extensive preparation, mainly the proper cooling and opening up the boiler together with a thorough cleaning of the boiler, including setting.

C-217. The cooling of the boiler shall be done cautiously so as not to put undue stress on the heated surfaces and setting. The damper shall be opened wide and the ash pit doors opened, allowing circulation of air in the usual way. The fire doors shall remain closed until after boiler is cooled.

C-218. During the cooling process the large doors in the boiler front shall be kept closed in order to prevent rapid cooling of tube ends.

C-219. After the furnace and lining have become well cooled the fire doors may be opened as well as the clean-out door at the rear preparatory to sweeping out the accumulated ash and soot.

C-220. The walls, baffles, tubes and shell shall be thoroughly swept down and the ash and soot removed to give the plant inspector opportunity to examine the parts closely and to eliminate danger from hot contact.

C-221. The tubes shall be well dusted and cleaned with steam soot blowers before the cooling operation has commenced. Steam shall not be used to clean tubes of a cold boiler as the moisture cements the soot and ash into a hard mass difficult to remove.

C-222. When boiler and setting are thoroughly cooled the blow-off valve shall be opened and the water removed. Then the manhole and handhole covers shall be removed to allow circulation of air.

C-223. The inside of shell, drums and tubes shall then be washed down thoroughly to remove mud, loose scale, etc. The washing operation shall be conducted from above as far as possible to carry the material downward to blow-off or lower handholes.

C-224. Before the washing operation is commenced a wire gauze screen of cylindrical form shall be inserted in each blow-off opening, projecting up into the boiler several inches, whose function is to prevent loose pieces of scale from entering and clogging the blow-off pipe.

C-225. The plant inspector shall have available the data on the boiler, dimensions, age, particulars as to previous defects noted, if any, and shall proceed to check up the pressure carrying capacity of boiler subject to conditions found during complete inspection.

External Inspection

C-226. The plant inspector shall examine the boiler for level, noting whether or not there has been any tendency to settlement, especially the level of the top tubes in horizontal return tubular boilers. He shall see that proper provision is made for expansion toward the back of boiler.

C-227. Examination shall then be made of the feed connection to see that it is clear and in good working condition.

C-228. Examination shall be made for evidences of corrosion on exterior of shell from rain coming down stack and leaking roofs, valves and pipes.

C-229. Inspection shall be made to see if there is any leakage of flame on dry sheets, particularly at the back arch of return tubular boilers, which should be entirely clear of rear tube sheet with sheet metal or asbestos rope covering gap.

Tie rods and buck stays shall be examined for condition and possible shifting from place.

C-230. Where the boiler top is covered with brick or other material, it should be removed sufficiently to allow proper inspection of riveted joints.

C-231. The plant inspector should note proximity of overhead shafts or any machinery which might drop down on or strike boiler in case of accident.

C-232. The plant inspector should note the presence of lumber, or other material piled on boiler or setting for purposes of drying or storage and which may endanger the setting or the safety and accessibility of the apparatus.

C-233. A careful examination shall be made of the safety valve, its connection to the boiler, escape pipe, its drip, supports, etc. He shall also test the safety valve by hand.

C-234. The water glass, gage cocks, water column connections and blow-offs shall be tested to see if the connections are free. Boiler pressure gages and master gages shall be tested.

Furnace and Parts Exposed to Fire

C-235. The plant inspector shall go into the furnace for the examination of the exterior of the tubes, shell, brickwork, etc.

C-236. He shall examine carefully for bulges over the fire, leaky rivets, loose rivets, rivets out of alignment, corrosion, wasting away of plates, cracks, etc.

C-237. The plant inspector shall scrape the shell and tap it thoroughly with hammer to detect thin places. He shall check thickness of plates with steel scale measurement. He shall examine joints and sheets over the fire particularly for possible fire cracks.

C-238. The plant inspector shall examine the setting for cracks, settlement and loose brick which may lean against the boiler. Where brickwork is used as insulation of steel supporting members it shall be examined to see that it is in good condition and that the air space, if any, is maintained. The furnace lining shall be examined for spauling, cracking and settlement. In vertical boilers, bridge walls shall be inspected to see that the mud drum is properly protected. The plant inspector shall examine baffle and check walls particularly for holes which may permit flaming through.

C-239. The blow-off connection should be examined carefully for corrosion and weakness where it screws into the boiler. The protecting cover of brick or tile should be intact and not interfere in any way with the expansion of the boiler or pipe.

C-240. Particular attention shall be given the tube ends and tube sheets in the case of horizontal return tubular boilers, the plant inspector noting any corrosion of the sheets, signs of leaking tubes, excessive thinning of the tubes from repeated rollings, and any cracks in the tube ends.

C-241. The plant inspector shall note any tendency to corrosion from leakage of manhole and handholes under tubes in tube sheets of return tubular boilers.

Internal Inspection

C-242. The plant inspector shall enter the drums of the boiler to make personal examination of conditions, first making sure that they have been properly ventilated and that there is no inflammable gas present from oil used to coat the boiler as the water level is lowered.

C-243. Before entering the shell or drum the plant inspector shall see that the blow-off valve, the main steam valve and other valves are locked and the keys in his possession.

C-244. Careful examination of the interior of the boiler shall be made for pitting, corrosion, scale and thin places in shell. The upper half of drums in the steam space shall be examined particularly for signs of grease and oil.

C-245. The interior of the tubes should be examined for scale and deposits and the space between the tubes in case of return tubular boiler made visible by lowering candle or small light between them for the purpose of making sure that there is no restriction of the circulation.

C-246. The location of the feed discharge and condition of the trough under it shall be noted. Dry pipes shall be examined to see that their openings and perforations are free from deposits. All interior fittings shall be examined for loose connections.

C-247. The interior face of the riveted joints shall be examined for condition of riveting, thinness of metal, corrosion, cracks, etc. The plant inspector shall note wasting away and cracking of stays and braces. Particular note shall be made of any welded stays or braces.

C-248. The fusible plug, if used, shall be examined, the top scraped to expose the condition of the metal and the plug renewed in case it has seen a year of service. The surface of the boiler about the plug shall also be scraped.

Inspection of Appurtenances and Supports

C-249. An examination of the condition of the main header and its connections to boiler shall be made to ascertain that it is properly supported, that due allowance is made for expansion without throwing strains on the boiler, that the non-return stop-valves are in good working condition and so placed that there is no pocket in the connection to hold water.

C-250. The plant inspector shall note the position of the steam gage, gage cocks, ascertain that the pipes leading to the water column, and water glass are level, and by leveling across the top row of tubes or from the position of the fusible plug check the position of the water glass.

C-251. Check pipe line and all exterior supports to see that the proper tension and alinement is maintained. Where boiler foundations are independent of building foundations, joints on the steam and feed connections shall be disconnected once a year to check possible settlements.

C-252. In addition to the above inspections, the plant inspector shall observe the condition of the interior of boiler at least once in every three months or at more frequent intervals if the boiler is opened for cleaning or repairs. Each time the boiler is removed from service, the plant inspector shall look for signs of defects where observations cannot be taken while the boiler is in operation.

C-253. A record of each inspection shall be kept in a uniform manner so that any change of condition can be definitely compared especially with reference to thickness of scale, corrosion, cracks, etc.

Care and Management

C-254. The plant inspector shall note particularly any evidences of carelessness in the care and management of the boiler and its appurtenances.

C-255. The plant inspector shall demand immediate remedy of any unsafe conditions or undesirable practices he may uncover and shall report fully on the results of his inspection to the owners of the boiler plant, promptly.

C-256. The plant inspector shall be furnished a copy of all reports of inspections made by authorized inspectors and shall see that all recommendations in such reports are promptly and carefully carried to completion.

Engineering Scholarships.—The Mechanical Division of the American Railway Association has four scholarships at Stevens Institute of Technology, Hoboken, N. J., two of which are now vacant. These scholarships are available for the sons of members of the division and cover the regular tuition charges for a four-year course, leading to the degree of Mechanical Engineer (M. E.). The course offered also includes instruction in electrical, civil and other branches of engineering.

Boiler Inspecting in South Africa

Details of Boiler Supervision and Qualifications and Experiences of Inspectors in a Strange Land

By George Cecil

Although the activities of the boiler inspector in South Africa are restricted by the lack of manufacturing concerns, the railways and the docks keep the small corps more or less busy. True, in an area of over a million square miles there are but ten thousand miles of railways; but the docks with their shipbuilding and repairing yards, and innumerable cranes, find employment for the boiler inspector, as also do the mines. The man whose work pins him down to Capetown or Port Elizabeth, seldom has time to be idle, for apart from the actual inspecting, many complicated returns must be kept. He is "administered" by the government, his duties being associated with endless red tape procedure. The appointment certainly is worth having; but it is not without vexatious worries. Those who pass the necessary qualifying examination, though assured of an adequate living, are subjected to a good deal of worry. They cannot escape from officialism.

Restriction Placed on Boilers

Before the Union of South Africa was instituted the boiler inspector might go about his work in a haphazard manner. Users of steam power often were their own inspectors and if an accident occurred, resulting in the death of a Kaffir engineer, the boiler was patched up, and all went on as usual—till it again burst. Kaffir engineers were plentiful; and being fatalists, they accepted the job knowing that something unexpected might happen at any moment. Something often did, and, for that matter, trouble still arises.

The Boer farmer in the *back-veldt*, for example, has no sympathy with restrictions imposed by the British Government. Seldom does he trouble himself about having the boiler of the engine which drives his threshing-machine examined by an inspector. "It has," he argues, "lasted this season, and, if the *Allemachter* is willing, it no doubt will last another." Only when the farmer himself is hurt does he consider repairs necessary. In other respects the Boer reposes boundless trust in Providence, a belief which has gained for him the high opinion of the good missionaries, who, as elsewhere, swarm in South Africa. They even invade business premises—intent on converting the heathen.

Applicants for Inspection Jobs

Sometimes the Boer, anxious to better himself, applies for the post of boiler inspector. But his ambition seldom is gratified, for the authorities find *Mynheer* too "slim" ("slim," in the local jargon, signifies "cunning"). He has been tried, and with the result that boilers have burst soon after Piet has passed them. The South African descendant of the old dutch settlers is ever shadowed by suspicion, and doubtless ever will be. During the South African war he gave himself away too often. The Africander (Briton born in the Union) stands a better chance, though boiler inspectors imported from England are most favored, much to the annoyance of the Africanders. Feeling runs high.

Lately the Kaffirs and Hottentots, as well as numerous half-castes, have agitated for employment in this direction. Egged on by the missionaries, and rendered eloquent by trade gin, they have their claims, even directly with the government. The petitions have fallen on deaf ears.

The man who works in a large town has an easy enough time of it. There is no difficulty in getting about; his hours are regular; the life is one of comparative ease. When, however, he is sent to a distant railway center, the journey may be long and tiring, and the accommodation most inadequate. For the South African provincial hotel is a horror among horrors, deep in dust and dirt, and alive with fierce insects, while tinned food is a poor substitute for meat which has been freshly killed. The journey also is an expensive affair. The boiler inspector is allowed a free ticket, and, within certain limits, hotel expenses. But he must provide himself with such minor luxuries as fruit, and, in the "hot weather," ice; and if the hotel fare is found to be uneatable, a simple dainty, such as an omelette, is paid for out of his own pocket, a very stiff price being charged for it. Really, a dog's life.

Petty Graft Sometimes Discovered

At the same time, the Africander boiler inspector has been known to abuse the hotel allowance. One man, on returning to headquarters, produced a medical certificate to the effect that he had fallen ill—and that champagne was found necessary to his health. He put in a hotel bill which included six bottles in half that number of days. Upon an inquiry being held, it was found that the supposed invalid had been three parts drunk before retiring each night and that the doctor attending him had assisted in the consumption of the tipple. It also transpired that the boilers passed by him should have been condemned.

The delinquent lost his appointment, and it was some months before the Africander boiler inspectors recovered from the stigma thus placed upon them. The occurrence took place early last year; but it still is remembered.

Methods of Travel

Sometimes the authorities at Capetown, suspecting the provincial users of steam power of employing boilers which are a menace to all who go near them, despatch a boiler inspector into the boundless *veldt*. He travels in a huge springless wagon, protected against the relentlessly fierce sun by a white tarpaulin awning, and drawn by a team of oxen, a black boy on the driver's seat. Dried *biltong*, as well as less unedible provisions, are stored in the lockers; a bed is rigged up at night; and the *Baas* carries a rifle on the chance of coming across a herd of deer. The gun also is handy in case of robbers, who, catching the occupant of the wagon unawares, may put him out of action and make way with the cattle—which are dearly prized as a marketable commodity. The native, intent on turning an occasion to account, sticks at nothing.

Occasionally the oxen falling sick, die, the boiler inspector being left to reach the destined scene of activities as best he may. The unfortunate fellow has been known to perish of hunger and thirst by the roadside, his body eventually being found with the *assvogels* (vultures) and hyenas fighting over the gruesome remains. Keen though the boiler inspector is on securing the traveling allowance which is granted to all who are on *trek*, he is not always flattered by being selected for the dangerous adventure. Even a provincial hotel is preferable to being stranded in the inhospitable wilds.

The Boers, on learning of the ill-starred man's fate, show no compassion . . . "It is," they piously declare, "a judgment on the interfering one! The *Allemachter* has willed

(*Continued on page 234*)

Locomotive Boiler Failures of Recent Occurrence

The Bureau of Locomotive Inspection Reports Accidents Caused by Crown Sheet and Arch Tube Failures

SPECIAL reports recently made by the chief inspector of the Bureau of Locomotive Inspection to the Interstate Commerce Commission covering locomotive boiler accidents include several which should be given careful study by the men in the shops as well as by the operators. These reports in some detail are given below:

Crown Sheet Failure Causes Serious Accidents

The crown sheet of Chicago, Rock Island & Pacific Railroad locomotive 1935 failed while hauling a freight train at an estimated speed of 25 miles per hour, resulting in the serious injury of three employees on January 30, 1923. It left Bucklin, Kans., at 8:40 p. m., and when at a point approximately 23 miles from Bucklin, about 1 mile west of Mineola, Kans., the crown sheet failed, resulting in the injury of the engine crew who were in the cab of the locomotive at the time of the accident and who were burned by the scalding water and steam escaping from the boiler into the firebox and into the cab of the locomotive.

Construction of Boiler

This was a 2-8-0 type locomotive with extended wagon-top boiler, equipped with radial stay firebox of three-piece construction and four arch tubes carrying the brick arch. The crown sheet was supported by 18 longitudinal and 25 transverse rows of radial stays. The six longitudinal rows of stays at the center of the crown sheet were of the button-head type with body 1 inch in diameter upset to 1 3/16 inches diameter at top and to 1 5/16 inches diameter at lower end. The remainder of the crown stays were of the driven-head type. The crown sheet was 4¾ inches higher at the front end than at the back end.

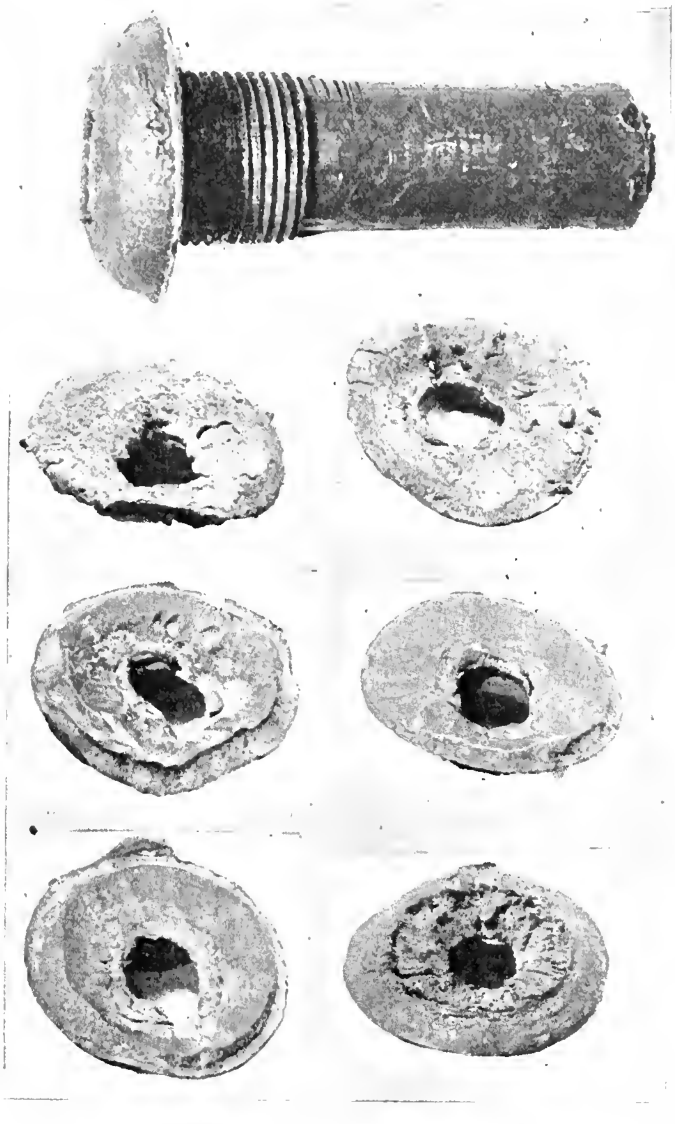


Fig. 1.—Type of Button-head Bolt Applied and Several Burned Heads Found After Accident

Examination of Firebox

The crown sheet pocketed to a maximum depth of 4¼ inches, beginning at the third transverse row of stays back of the flue sheet to and including the eleventh transverse row, and from the second longitudinal row on the left of the center line of crown sheet to the fifth longitudinal row on the right side of crown sheet, making the pocketed area approximately 48 inches long by 35 inches in width.

No portion of the crown sheet showed any evidence of having been overheated, nor was the scale disturbed on the water side of the sheet other than in the pocketed area, which disturbance was caused by the bending action of the sheet as it was forced downward by the steam pressure.

The crown sheet pulled off of 57 radial stays, 41 of which had button heads, while the remaining 16 had hammered heads. The button heads were pulled off the stays and a number of them found in the ashes which were removed from the firebox and ash pan after the accident. The type of button-head stay originally applied is illustrated by Fig. 1, as well as the badly burned button heads that were found in the ashes. By comparing the four lower sections with the original bolt, the extent to which the button heads had been calked and distorted is apparent.

Fig. 2 (top) is another view showing the condition of a button head that still remained in the sheet after the accident, while Fig. 2 (lower) shows the extent to which the threads were corroded and worn away, due evidently to constant and long leakage, which is further evidenced by the condition in which the button heads were found.

Appurtenances

This locomotive was equipped with one water glass and three gage cocks, all of which were found in good condition. The lowest reading of water glass was 4 inches above the highest part of the crown sheet, while the lowest gage cock was 5¼ inches above the highest part of crown sheet.

Injectors, safety valves, and steam gages were removed and tested and found to be in good condition. The check valves had 7 16-inch lift and were in good condition. The tank, tank wells, and hose were in good condition; the right tank hose strainer was in good condition, while portions of the openings in the left strainer were obstructed by an accumulation of weeds and straw.

Daily Inspection Reports

Daily inspection reports on file at Herington and Pratt, Kans., were examined and the following items which might have had a bearing on the accident had been reported and which bear evidence of the poor condition of the firebox and flues prior to the time of the accident:

Date. 1923.		Defects.
Jan.	4	Calk leaks in firebox. Report approved by foreman, without notation, indicating repairs had been made.
	6	Flues leaking. Both side sheets leaking. Crown bolts leaking out of Pratt. Inspect engine for other defects account of 16 hours on duty. Report approved by foreman, without notation, indicating repairs had been made.
	8	Calk all leaks in firebox. Report approved by foreman.
	12	Back end of arch-bar pipe leaking. Crown bolts and front flue sheet seam leaking. Report approved by foreman, without notation, indicating repairs had been made.
	14	Engine leaking bad. Report approved by foreman, without notation, indicating repairs had been made.
	16	Right inside arch pipe leaks in back sheet. Report approved by foreman.
	21	Calk leaks in firebox. Report approved by foreman.
	22	Flues leaking. Report approved by foreman.
	24	Calk all leaks in firebox. Calk stay bolts in boiler head, right side; they leak so bad when engine is working engineer can't see nor can't stand to breathe the steam. Report approved by foreman.

This locomotive was in shop at Pratt, Kans., undergoing repairs from January 24 to 30, during which time the following work was reported to have been done:

All flues expanded.

Eight to nine inches of side sheet seams rewelded.

Fig. 2.—Top View Shows Bolt Taken from Sheet After Explosion. Lower—Extent of Corrosion

Two center arch tubes applied new.

Two staybolts in right side sheet renewed.

About 50 staybolts in side sheet calked and hammered up.

Boiler washed.

Left front driving wheel tire flange built up.

Conclusion

It is apparent that this failure was entirely due to the crown sheet being without proper support, due to the threads on the radial stays and in the crown sheet being badly corroded and wasted away, and the badly damaged condition of the button-head stays caused by constant calking because of leakage, until their holding power was practically destroyed.

Back Head Repair Fails on Passenger Locomotive

On March 10, 1923, there occurred an accident to the boiler of Richmond, Fredericksburg & Potomac locomotive 69, near Milford, Va., while hauling passenger train No. 29 at an estimated speed of 35 miles per hour, resulting in fatal injury to the engineer and the serious injury to the fireman.

The train left Washington, D. C., at 5:10 p. m., proceeded without unusual incident until near Milford, Va., about 79 miles south of Washington, when at 7:30 p. m. a crack in the right side of the boiler back head, which had been repaired by the autogenous welding process, suddenly failed, emitting steam and water from the boiler.

The force with which the scalding water and steam escaped through the rupture compelled the engineer to leave the cab without being able to close the throttle or apply the brakes in order to stop the train in the usual way.

The fireman, when interviewed, stated that he was standing in the left gangway when the accident occurred, describing the noise as a ripping sound, somewhat like the explosion of a firecracker, and said that when he turned to look into the cab after the explosion the engineer was standing on the cab deck enveloped in steam and water. He and the engineer then climbed out around the left side of the cab to the running board and to the front end of the locomotive, where the angle cock was opened, applying the brakes in emergency, which brought the train to a stop.

Our investigation disclosed that on April 13, 1921, a crack in the right side of boiler back head was repaired by the autogenous welding process. The welding had been reinforced and covered an area of 3½ inches wide by 25¾ inches long. Soon after this another crack developed 2¼ inches to the right, 13 inches long, and parallel to the original crack. The latter crack was also repaired by the autogenous welding process at a later date, not definitely established, but it appears from such information as we were able to obtain that this repair was made on or about April 14 or 15, 1921, soon after the first crack developed. It was the latter crack which failed, causing this accident, which indicates that the welding had been done approximately 23 months prior to failure. Fig. 3 illustrates the method of repair and the extent of the crack. When the failure occurred the crack extended three-fourths inch at the bottom and 7¾ inches at the top, making a total length of 21½ inches.

Richmond, Fredericksburg & Potomac passenger-train locomotives are housed and repaired while in Washington at the Washington Terminal Co. shop. On February 22, 1923, while at the Washington terminal shop, there was reported on locomotive 69: "Staybolt leaking, inside of cab, left side." An examination disclosed that a crack 8 inches long on the left side of boiler back head, which had been repaired by the autogenous welding process, had opened up. Repairs were then made by applying a patch 23 inches in length and 7¾ inches wide over the crack.

This and other similar accidents which have occurred are conclusive evidence that repairs of this nature should not be permitted except where the welding is covered by a patch properly applied, which will prevent such accidents in case of failure of the welded seam.

It is impossible to estimate the serious results which might follow an accident of this nature to a fast-moving passenger train or any other train where the enginemen are forced to leave the cab without being able to close the throttle or apply the brakes, thus leaving the train to proceed uncontrolled.

Arch Tube on Pennsylvania Locomotive Fails

On May 5 an arch tube pulled out of the throat sheet of Pennsylvania locomotive 8255, resulting in the serious injury of the engineer and the fireman while drifting "light" at an estimated speed of 5 miles per hour; steam pressure about 180 pounds.

The engineer stated that after the failure occurred he could not see anything in the cab, because of the flames and escaping steam, and that he left the engine, ran to the rear of the tender, and opened the angle cock to apply the brakes, which brought the engine to a stop. The fireman was sitting on the seat box at the time of the accident and jumped out of the gangway to avoid the flames which struck him in the face. This locomotive was equipped with automatic fire door, which remained closed and possibly prevented more serious injuries.

Examination of Arch Tubes

This locomotive was equipped with five arch tubes 3½ inches in diameter. Examination disclosed that the right No. 2 arch tube had pulled out of the throat sheet and had been forced down below the hole by the weight of the brick

Fig. 3.—Fatal Crack Occurred in a Welded Repair Job

arch, thus leaving the 3½-inch hole open, through which the water and steam in the boiler escaped into the firebox and cab. The end of the tube showed that the tube had extended into the water space about one-eighth inch, but had not been belled or beaded to secure it in place and had not been sufficiently rolled to leave an impression on the tube.

Examination of the other arch tubes disclosed that they had not been properly applied. The back end of the tube which failed extended into the water space about five-sixteenths inch. The back end of the center tube extended into the water space about one-fourth inch and the front end was flush with the water side of the flue sheet. The left No. 2 tube extended through the sheet about three-sixteenths inch at the back and five-sixteenths inch at the front and showed indications of a slight leak at the back end. The right and left No. 1 tubes extended through the sheets about three-eighths inch; however, none of the arch tubes had been belled or beaded to secure them in place.

While records were not produced showing when or where these tubes were applied, information tends to show that they were applied in November, 1922, at Shire Oaks, Pa. Various inspections at the time of repairs indicated the condition of the tubes to be "good," notwithstanding it is evident that these tubes were improperly applied and that they were in an unsafe condition at the time of the inspections referred to.

The unsafe condition created by arch tubes which are not properly rolled and belled or beaded to secure them in place and kept clean and free from scale while in service is so generally well recognized that comment hardly seems necessary, as the requirements are so clearly set out and described by the law and rules.

Another Arch Tube Failure

At 1:50 p. m. on June 7, 1923, an arch tube pulled out of the throat sheet in boiler of Pennsylvania railroad locomotive 8854, resulting in the serious injury of one employe.

Locomotive 8854 was equipped with four arch tubes 3 inches in diameter. The investigation disclosed that the tube which pulled out of the sheet had not been applied at right angles with the sheet, it being flush with the water side of the throat sheet at the top and extended into the water space only ⅛ inch at the bottom and was not belled or beaded at either end to secure it in place. The other arch tubes were badly mud burned and blistered, right No. 1 tube had four blisters, left Nos. 1 and 2 tubes had six and ten blisters, respectively.

Condition of Firebox

The flues had been electrically welded to the back flue sheet, many of which were cracked and in bad condition. A patch had been applied to the knuckle of the back flue sheet and was found in bad condition, and had been since May 1.

It could not be ascertained when or where the arch tubes were applied. The monthly locomotive inspection and repair report dated at Logansport, Ind., on May 18, 1923, subscribed and sworn to by the inspector and approved by the officer in charge, shows the flues, firebox sheets and arch tubes to be in "good" condition, which could not be correct as disclosed by the official investigation of this accident and as evidenced by the frequent reports showing the defective condition of the firebox prior to the date of the sworn report.

An Exact Method for Developing a Cone

By Wilson Blackburn

In an endeavor to help the readers of the Boilermaker, I submit the following enclosed sketches and calculations together with an example of the only true way of laying out a cone, other than by use of trammels. Too often in the past the average writer when solving for the versed sine has lost sight of the fact that the stretchout of a cone is in reality an arc of a circle. The solution I present is equally correct for a cone made up of numerous sections as a cone of one piece providing the layout divides the angle A of the stretchout and the length of the arc by the number of pieces, when getting out a section of the chord E. No doubt this will be criticized on account of the use of trigonometry, but it is up to every layerout to study and master the intricacies of "trig" as the day is not far distant when approximate methods will no longer be tolerated.

To find the radius of the cone we must find the angle a of the sketch as follows: tangent angle $a = \frac{\frac{1}{2}(D - d)}{C}$, radius $R = \frac{\frac{1}{2}(D - d)}{\text{Sine } a}$. Next to find the length of the chord E which is the first line necessary to begin the development, we must first calculate the number of degrees enclosed within the arc or stretchout as follows: angle $A = \frac{57.29578 \times D}{R}$.

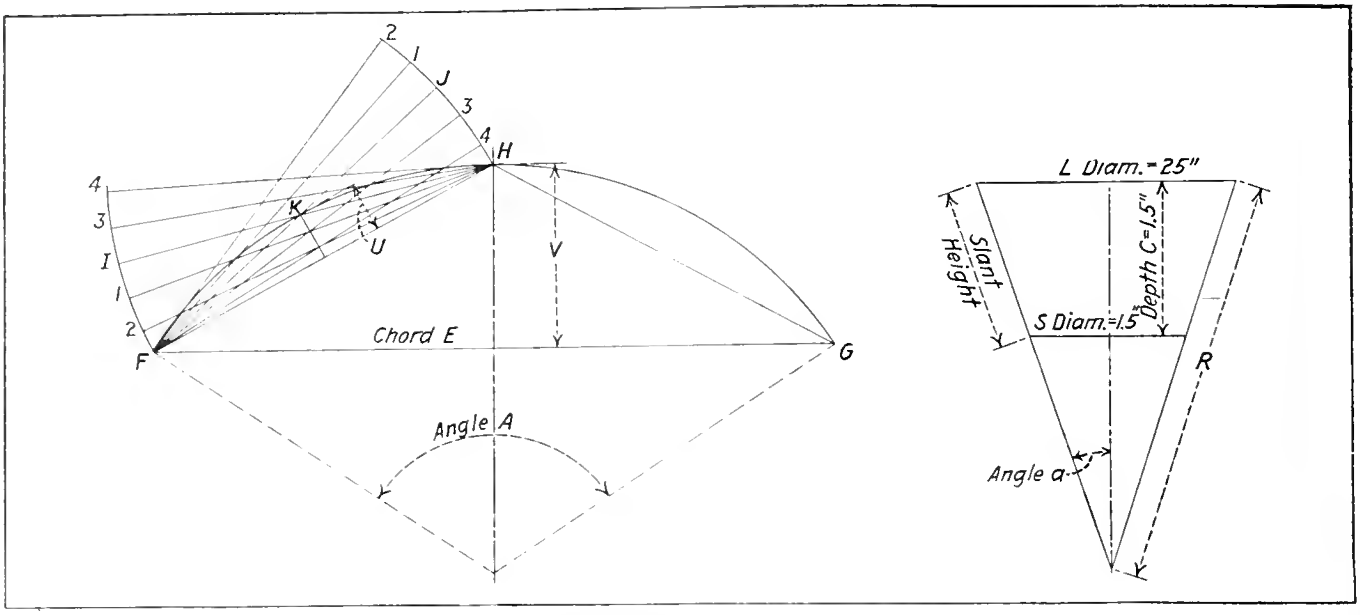


Fig. 1.—Application of Trigonometry to the Development of a Cone

The chord E is then $2(R \cdot \text{sine } \frac{1}{2} \text{ angle } A)$.

The versed sine $V = (1 - \cos \frac{1}{2} \text{ angle } A)\, R$.

We now have three points required for the development. Lay off the length of chord E as per example and on its center erect a perpendicular equal in length to the versed sine V. Mark these points respectively F, H and G. Connect H to G by a straight line, also H to F. Now to determine another point on either side of H we find the versed sine U as follows: $U = (1 - \cos \frac{1}{2} \text{ angle } A)\, R$. Half way between points H and F erect a perpendicular equal in length to this versed sine U. Now from H and F respectively with a radius equal to H-F, strike arcs as shown in example. Next draw lines from H through the point K and from F through K, each line cutting one of the arcs locating points I and J. Lay off equal spaces on either side of I and J numbering them as per example. Lines drawn from H to these spaces so found will cut lines of the same number drawn from F to the other arc, locating some more points which when struck through by a curve gives the true camber line.

To lay out the other circle the trammels may be used set to the length of the slant height which may be found by

$$\text{"trig." slant height} = \frac{C}{\text{Cos angle } a}.$$

Example

$$\text{Tangent angle } a = \frac{\frac{1}{2}(D - d)}{C}$$

$$= \frac{\frac{1}{2} \times 1}{1.5} = \frac{.5}{1.5}$$

$$= .3333$$

$$\text{Angle } a = 18° \; 26'$$

$$\text{Radius } R = \frac{\frac{1}{2} D}{\text{Sine } a} = \frac{\frac{1}{2} \times 2\frac{1}{2}}{.31620} = 3.96''$$

$$\text{Angle } A = \frac{57.29578 \times 3.1416 \times 2.5}{3.96}$$

$$= 113.8°$$

$$\tfrac{1}{2} \text{ Chord } E = R \times \text{Sine } \tfrac{1}{2} \text{ angle } A$$

$$= 3.96 \times \text{Sine } 56° \; 54'$$

$$= 3.96 \times .83772$$

$$= 3 \; 5/16''$$

$$\text{Chord } E = 6 \; 5/8''$$

$$\text{Versed Sine } V = (1 - \cos \tfrac{1}{2} \text{ angle } A) \times R$$

$$= (1 - .54610) \times 3.96$$

$$= .4539 \times 3.96$$

$$= 1.797 = 1 \; 25/32''$$

$$\text{Versed Sine } U = (1 - \text{Cos } \tfrac{1}{4} \text{ angle } A)\, R$$

$$= (1 - \text{Cos } 28° \; 27') \times 3.9$$

$$= (1 - .87923) \times 3.9$$

$$= .12077 \times 3.9$$

$$= .47 \text{ in.} = 13/32 \text{ in.}$$

Vancouver, B. C. Wilson Blackburn.

Boiler Inspecting in South Africa

(*Continued from page 230*)

that his bones should bleach in the sun!" . . . Delightful people—to avoid.

When the boiler inspector is on *trek* he may turn the occasion to account by superintending the patching-up of a much worn engine, for a knowledge of mechanical engineering often is his. The fee paid is a trifling one; but, as the native dictum so aptly puts it, "the pile of silver eventually is turned to gold." So, with luck, the expert returns from the official trip richer than when he started. He also has a chance of filling the wagon with country produce; bales of ostrich feathers and other saleable lines.

The government objects to the boiler inspector putting official time and the official vehicle to unofficial use; and, when instances are discovered, it may go ill with the offender. The astute speculator who is sufficiently wide-awake (and he usually is very "slim") outspans at a convenient point, transferring the merchandise to another wagon and pursuing a blameless way to headquarters. Having reported to his superior and handed in the necessary papers, he is at liberty to turn to commercial negotiations. The "slim" boiler inspector generally does well out of such dealings. Some years ago the inspector's *trek* brought him into contact with natives who had acquired diamonds under suspicious circumstances, and he who was not particular would do a deal without asking convenient questions of the seller.

When the boiler inspector has to examine a Boer-owned boiler, the copy of the report which is given to the owner of the plant is in *Taal*, the mother-tongue of these people. Many of them are by way of speaking English, with a strange colonial accent; but the "*Taal*" is their recognized language. 'Tis considered unpatriotic to know any other.

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CONTENTS

From time to time, articles dealing with methods of high power boiler inspection have been published in The Boiler Maker, but since these have represented the practice of individual companies there has been an opportunity for differences of opinion as to the best procedure. The rules for power boiler inspection published elsewhere in this issue should prove to be of great assistance to those who build boilers as well as to those who operate and inspect them since they indicate the specific safety requirements to which A.S.M.E. boilers will be held.

These rules constitute a section of the preliminary report of a sub-committee of the A.S.M.E. Boiler Code Committee prepared on the operation and care of power boilers. The rules apply to steam boilers constructed in accordance with Part I Section I of the Boiler Code and to those not subject to Federal inspection and control including marine boilers, boiler of steam locomotives and other types.

Every shop in which the men make a study of their work has a veriety of time and labor-saving appliances built from materials at hand without a very great expenditure of time or money. In every case such equipment promotes the efficiency of the shop in a small way and makes one or more of the operations to which it can be adapted easier to perform.

A number of the devices that have been built and used successfully and that can be made and applied wherever men are interested enough to put them together, are shown in another part of this issue. Further articles describing time-saving devices and shop kinks will appear later.

Practically every one of our readers will admit that material of this kind is helpful but, since a single contributor cannot cover all the shops in the country and dig out the thousand-and-one time savers that every shop has developed, we want more of our readers to join the ranks of those who write for The Boiler Maker. It is not practicable to write individually to our subscribers, asking them about their work, but this request is to be considered a personal invitation to every one to communicate more frequently with us and tell the rest of the trade what he is doing through the medium of our pages.

Real progress is being made in the art of autogenous welding—the measure of this advance being indicated by its successful applications. In the boiler making industry and allied fields, welding is playing an increasingly important part. In high pressure boilers it can be applied to advantage where the welds are not required to carry the stress, as an aid to tightness and strength.

In Scotch marine boiler construction, certain shops make a practice of welding seams and stay nuts in the combustion chambers to a point 2 feet above the center line of the furnace. Inside and outside butt strap edges are welded. Saddle lug calking strips are welded to the boiler shell. Combustion chamber seams exposed to the direct action of the flame are welded inside and out to protect the plate edges against possible leaks. Screw stays up to 2 feet above the center line of the furnace are fitted with special round collar nuts which are welded after being screwed on the stays.

Low pressure all-welded steel boilers are being built in competition with other types of heating boilers at a greatly reduced production cost. The boilers so constructed have proved extremely serviceable and uniform in their operating characteristics.

High pressure tanks, chemical retorts, pressure cooking pots, as well as storage tanks for a variety of purposes are being welded on a production basis at various shops throughout the country with great success.

When the recommendations of the Pressure Vessel Committee of the American Bureau of Welding resulting from the tests conducted at the Bureau of Standards in Washington from December 4, 1922, to February 1, 1923, have been considered by the A.S.M.E. Boiler Code Committee with a view to the final formulation of the pressure vessel code, a more widespread and more uniform application of welding will be possible in this industry. The recommendations of the Pressure Vessel Committee will be published in full in a later issue of this magazine.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Semi-Hot Bolt Header with Automatic Feed

A NEW and radical design of one-inch, semi-hot bolt and rivet header with automatic feed has been developed by the engineers of the National Machinery Company, Tiffin, Ohio, and recently placed on the market. The bed frame in the new design, illustrated in Fig. 1, is

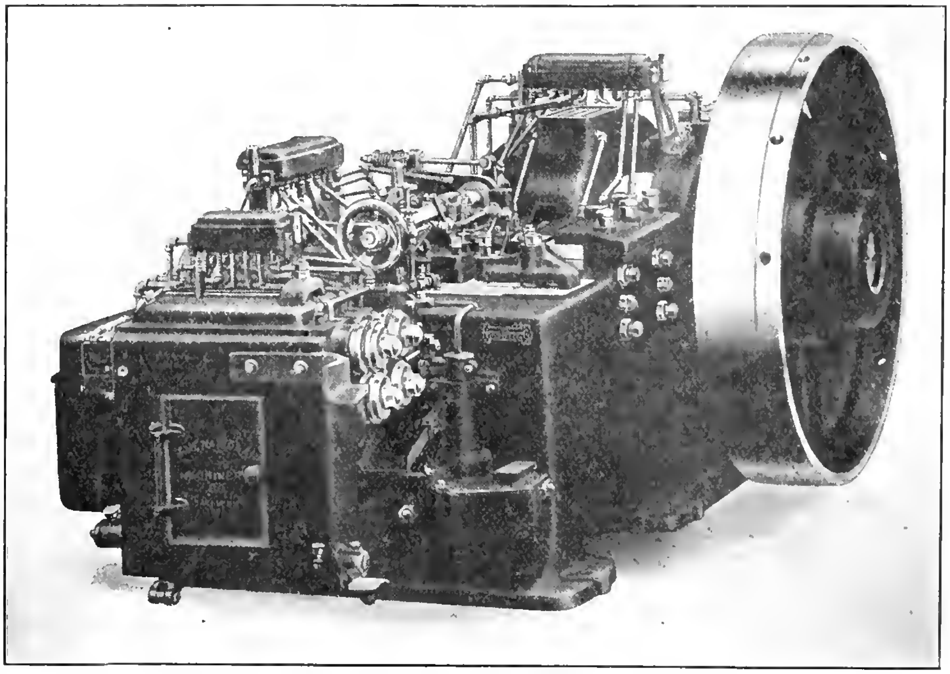


Fig. 1—National Semi-Hot Bolt and Rivet Header with Automatic Feed

only half as long as in previous models, and spring is practically eliminated, making it unnecessary to batter the heading tool against the gripping dies to properly fill out the head of the work. Some idea of the great strength and stiffness of the design is indicated by the fact that while the machine weighs 31,500 pounds, it is only 51¾ inches from the center of the main shaft to the face plate, and the main shaft at the crank is 11½ inches in diameter.

The hard service and consequent wear on earlier automatic feed headers has been met by greatly increasing the size of all bearings and working surfaces, and adopting such features as the "suspended type" heading and gripping slides with bearings above the path of scale and water. All of the gripping toggles have been increased in size and are located horizontally to insure proper lubrication. The ultimate pressure that can be thrown upon the toggles and gripping mechanism is limited by a new type of automatic relief, making destructive pressures impossible. Last but not least, a fully automatic oiling system which oils every bearing of the machine automatically every ten minutes is provided, supplying a predetermined amount of oil for each bearing, proportionate to its service requirements. In a three-year test period, several machines of the new type have required no repairs or relinement, and working parts show practically no appreciable wear.

The previous trouble in die setting, resulting from the lack of a horizontal adjustment for the heading tool, has been overcome by mounting the heading tool in a bolster plate on the front of the heading slide, which, being screw-controlled in all directions, provides for quick and accurate adjustment of the heading tool with the gripping dies. This construction is outlined in Fig. 2.

The lack of control of the gripping or holding time in the old machines has been corrected by providing an adjustment in the gripping toggles. Consequently, on work requiring minimum gather or hold, such as rivets, it is possible to reduce the holding time to the exact requirement. On work such as 1-in. U. S. square head bolts, or any work requiring a large amount of gather, the gather is obtainable by means of this adjustment. The practical result of limiting the contact with the heated stock is a reduction in heating effect on the dies and lengthening of die life.

One of the difficulties of the old type of machine was an inherent defect in the design of the shearing mechanism, which tended to badly distort the end of the sheared bar, making it difficult to center the next head. This condition has been corrected in the new design by building the feed mechanism at an angle to the machine proper. This gives an angling shear, which, by compensating for the distortion, results in central heads, and makes it possible to upset and fill out an increased length of stock for large heads.

The powerful shearing and gripping mechanism, combined with the great strength and stiffness of the machine, enables work to be made at unusually low temperatures.

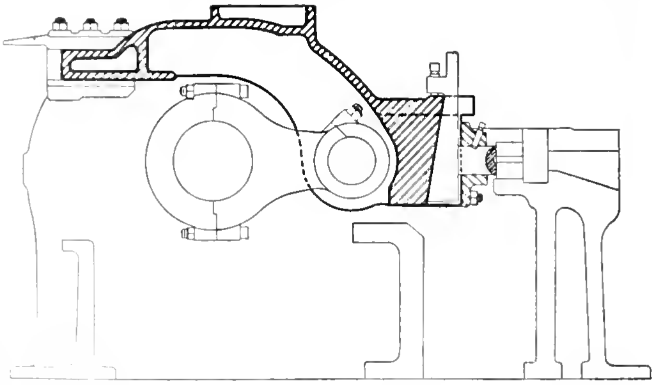


Fig. 2—Diagram Showing Heading Slide and Bolster Plate Construction

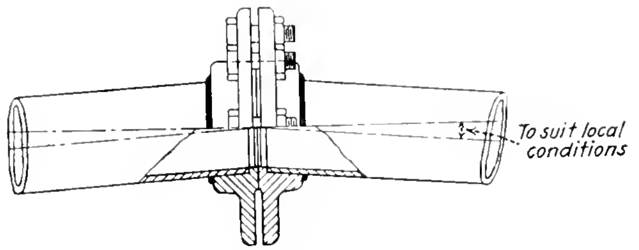
Rivets are made at 1,000 to 1,100 degrees F., and bolts at 1,200 to 1,500 degrees F. Records in big bolt plants show that the life of heading tools has been doubled and of gripping dies tripled.

Life of Boiler Washing Plants Increased

The rapid deterioration of enginehouse piping has been the cause of excessive maintenance costs for boiler washing plants. By the development of a so-called leadizing process of coating roundhouse piping, after the pipe is fabricated ready for installation, with a lead surface of sufficient thickness to withstand the abrasion due to ordinary handling and by substituting drop forged flanges shrunk and welded on the pipes, for threaded connections, the National Boiler Washing Company, Chicago, has overcome much of this excessive cost of maintenance.

The greatly increased permanency of the enginehouse piping thus provided makes practicable an initial installation of hot water boiler washing and filling equipment with mains of sufficient size to permit the future installation of additional capacity at comparatively small expense. The development of the tandem condenser permits the installation of additional condenser units as they may be needed to increase the number of locomotives that can be handled at one time, the additional storage capacity being provided by increasing the number of tanks up to the capacity of the mains.

Prior to the development of the leadizing process the greatest difficulty from corrosion was found to develop at the threaded connections. In order to eliminate this weak point and to overcome the additional weakness caused by bending the pipes to conform to the circle of the enginehouse the drop forged flange connections shown in the drawing were developed to replace the threaded connections. With these connections the roundhouse mains are laid out in the form of chords of the circle of the house and the flanges bored out at an angle varying from the axis by an amount sufficient to bring the faces of the adjoining flanges together, with the adjoining sections of pipe located normal to the center lines of the stalls. The flanges, thus bored, are shrunk and welded to the pipe, which has been cut to length, and the faces of the flanges are then accurately ground to the correct angle in a machine especially developed for the purpose. Since the development of the leadizing process on a commercial basis



Special Welded Drop-Forged Flange

the sections of pipe thus fabricated are further protected by the addition of a strong lead coating.

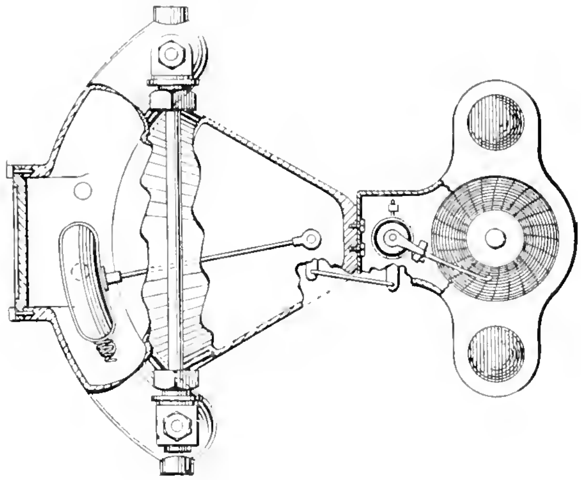
The leadizing process was first developed on the Atchison, Topeka & Santa Fe about seven years ago. It consisted in immersing the pipes or other steel to be coated in a hot bath of acetate of lead. The resulting chemical action causes the transfer of lead to the surface and iron to the bath, the action continuing only so long as any of the steel surface is exposed. The lead coating is therefore extremely thin and easily subjected to damage in handling.

To provide a commercially practicable coating the National Boiler Washing Company completes the lead deposit by a heavy electro plating process. After this the material is thoroughly washed and painted.

Water Recorder Promotes Safety

A recording device which maintains a 24-hour graphic record of the water level in a boiler has been developed by the Hackman Manufacturing Company, Milwaukee, Wis., under the name of the Hackman water recorder. Besides the continuous water level record, the device indicates the time the boiler was cut in, or cut out; how long the water was too low or too high; whether or not the water was foaming; whether the water glass has become clogged and other facts which should be known by the operator to realize the proper efficiency from the boiler.

The recorder consists of a water column constructed of steel connected to the water supply and to the boiler. In this



Device for Registering Water Level

column is a copper covered cork float connected with a suitable lever mechanism to the registering device. A waterproof union with the registering device at the right of the triangular-shaped float arm box prevents interference with the registering mechanism. A spring on the bottom of the float prevents the closing of the intake in the event that water gets too low in the boiler. The float is also connected to a gong, so that if the water level falls or rises above a determined level which the float mechanism is set to record, an alarm is sounded which continues until the water level has been restored. Two light signals are also operated by the float. The recorder is simply installed in place of the usual water column.

BUSINESS NOTES

D. W. Phillips, formerly connected with the Heine Boiler Co., in the capacity of shop superintendent of their St. Louis Mo., plant, is now shop superintendent with the International Engineering Works, Framingham, Mass.

C. C. Rosser, who for many years has been connected with the Detroit Seamless Steel Tubes Company, Detroit, Mich., has been appointed district sales manager with offices at 1206 Guardian building, Cleveland, Ohio.

The Surplus Steel Exchange, Inc., 7 Dey Street, New York, which was recently organized, announces the opening of an office in Chicago, at 2257 Oakdale Avenue, in charge of A. E. Thiffault and Raymond I. Caspers.

The Connecticut Blower Corporation, Hartford, Conn., has been incorporated under the laws of Delaware with capital of $250,000. M. E. Keeney, President, C. H. Keeney, Treasurer, C. E. Keeney, Secretary. This company has taken over the International Blower Company and the Hartford Sheet Metal Works.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. E. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Conical Roofs for Cylindrical Tanks

Q.—Please publish in proper order in "Answers" Dept., your own, or any other logical system, or method, of arriving at the following required data: Given:—The diameter of any vertical storage tank (for example, 10 feet 0 inch diameter and 30 feet 0 inch diameter). Required:—The minimum height of self-supporting roof, and minimum thickness of steel plate. This result as regards height and thickness of plate of course being for average snow and wind loads. The sketch on the attached sheet makes the above as plain as possible.—H. B. F.

A.—The following specifications on tank roofs have been adapted by the American Bridge Company:

The top of the tank will generally be covered with a conical roof of thin plates; and the pitch shall be 1 to 6. For tanks up to 22 feet in diameter the roof plates will be assumed to be self-supporting. If the diameter of the tank exceeds 22 feet, angle rafters shall be used to support the roof plates, which are generally ⅛ inch thick.

Plates of the following thickness will be assumed to be self-supporting up to 22 feet in diameter:

3/32-inch plate, up to a diameter of 18 feet.

⅛-inch plate, up to a diameter of 20 feet.

3/16-inch plate, up to a diameter of 22 feet.

Rivets in the roof plates are from ¼ to 5/16-inch in diameter, and are driven cold. These rivets need not be headed with a button set.

Where angle rafters are employed the load due to wind and snow is assumed to be 30 pounds per square foot. The load therefore is figured for a segment of the conical roof which may be assumed as triangular in shape.

For all practical purposes the size of the angle rafters is determined by considering the rafter a beam uniformly loaded, supporting the load due to the weight of the conical segment and the load due to wind and snow.

The bending moment of such a beam is determined from the formula:

$$M = \frac{W \times L}{8}$$

in which, M = bending moment pounds.
W = the load in pounds on the beam.
L = length of beam in inches.

The section modulus equals $\frac{M}{16{,}000}$. The value 16,000 is the safe stress in pounds per square inch on the structural seam.

From a structural handbook the size of the angle is indicated for the calculated section modulus.

Bursting and Working Pressure, Factor of Safety, Types of Blow-Off Valves and Connections

Q.—(1) If the factor of safety on a boiler were 5 and the boiler pressure 200 pounds per square inch would the bursting pressure be 200 × 5 = 1,000 pounds?

(2) A vertical firetube boiler recently came to my attention which did not have a globe valve in the steam space which would act as a blow-off valve. Does not the A. S. M. E. Boiler Code require that there should be one at this place and that the valve above the waterleg of the boiler must be at least one inch and not greater than 2½ inches (pipe size U. S. standard)? This boiler had a globe valve instead of a straightway valve for the mudring blow-out. Is this permissible?—C. B.

A.—The force tending to rupture a cylindrical boiler shell longitudinally, as on the plane *a-b-c-d*, Fig. 1, is represented by the inside diameter multiplied by the pressure times the shell length. Thus consider the inside diameter *a-b* of the shell to equal 60 inches, length of shell 12 feet or 144 inches and the steam pressure 100 pounds per square inch. The total pressure acting in the direction of the arrows is equal to 60 × 144 × 100 = 864,000 pounds.

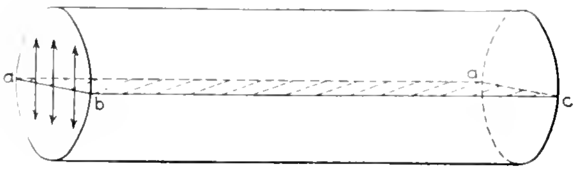


Fig. 1.—Pressure Acting in Cylindrical Shell

The strength of the shell to resist the pressure equals the resistance or tensile strength of the metal taken along the sides *b-c* and *a-d*.

It is customary in calculating the strength of boiler shells to consider the length as unity, that is, a length of 1 inch. Using data given, the following formulæ are evident:

$$Pd = 2tS$$

in which:

P = pressure in pounds per square inch.
d = inside diameter of boiler shell, inches.
t = thickness of boiler plate, inches.
S = tensile strength of plate, pounds per square inch.

and (2) $t = \frac{Pd}{2S}$

and (3) bursting pressure $= \frac{2tS}{d}$

As boiler shells are formed with longitudinal seams and as the joint is weaker than the solid plate, the strength of the joint as compared with the solid plate, known as the joint efficiency, must be taken into account. In addition to this, it is necessary to employ in the calculations a factor of safety. The factor of safety may be explained as the ratio between the safe working pressure and bursting pressure. For new boilers a factor of 5 is specified by the A. S. M. E. Boiler Code.

Representing the factor of safety by F and the efficiency

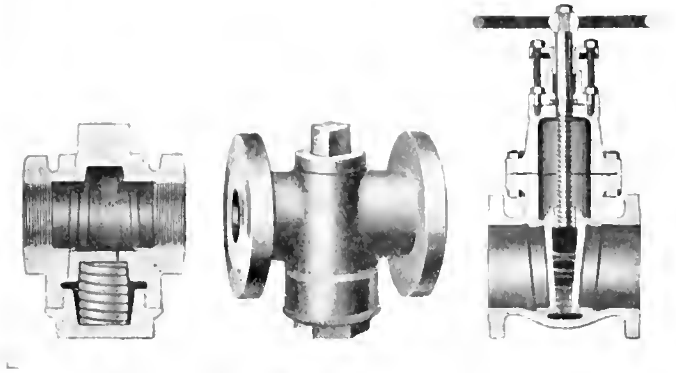


Fig. 2 (a).—Two Views of Blow-off Cock
Fig. 2 (b).—Gate Valve (At Right)

of the longitudinal joint by E and using their values in connection with those of formula (2), the following formula (4) is produced.

$$(4)\quad t = \frac{PdF}{2SE}$$

from which;

$$(5)\quad P = \frac{2tSE}{dF}$$

Example: Assuming that a boiler 60 inches inside diameter is to be built to carry 100 pounds per square inch from steel plate having a tensile strength of 55,000 pounds per square inch, efficiency of longitudinal joint to equal 80 percent; factor of safety, 5; determine the required plate thickness.

Solution:

Using these values in the formula (4)

$$t = \frac{100 \times 60 \times 5}{2 \times 55{,}000 \times 0.80} = 0.341 \text{ inch}$$

Using the plate thickness in the formula (5)

$$P = \frac{0.341 \times 2 \times 55{,}000 \times 0.80}{60 \times 5} = 100 \text{ pounds}$$

per square inch.

If the allowable working pressure on a boiler is 200 pounds per square inch and the factor of safety 5, the bursting pressure equals $200 \times 5 = 1{,}000$ pounds.

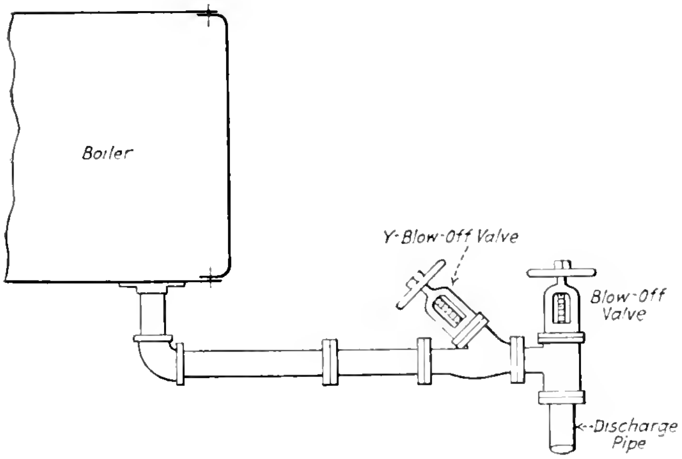


Fig. 3.—Arrangement of Blow-off Valves

For blow-off connections there are three types of valves commonly employed. In Fig. 2 (a) is represented a blow-off cock, and in (b) a gate valve. The blow-off or plug cock is used for surface blow-offs, especially on low and medium steam pressures. The tapering plug *a*, as will be noted, is held in place by a compensating spring *b* which automatically takes up wear.

Valves for High Pressure

The valve shown is of the extra heavy pattern used for high steam pressures. Blow-off valves are subjected to severe service due to the dirt and scale that is present at the bottom of the boiler. These substances in passing through the valves tend to cut the valves and valve seats; for that reason the valves should be opened wide for the blowing off operation. The section view (b) shows the interior construction of the valves and their body.

In Fig. 3 is shown a bottom blow-off connection with a *Y* pattern blow-off near the boiler and blow-off valve that connects with the discharge piping and *Y* blow-off. Every boiler blow-off should be equipped with two blow-off valves or a blow-off cock and a blow-off valve.

To blow down a boiler the *Y* or blow-off cock should be opened first and the blowing off controlled by the blow-off valve. When completing the operation the blow-off valve is closed first, then the *Y* or blow-off cock. Globe valves should not be used for blow-off valves.

The following rules on blow-off piping and valves are quoted from the A. S. M. E. Code:

Par. 307. *Blow-off Piping.* A surface blow-off shall not exceed 1½-inch-pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing or flanged connection, shall be used.

Par. 308. Each boiler shall have a bottom blow-off pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable; the minimum size of pipe and fittings shall be 1 inch and the maximum size shall be 2½ inches. Globe valves shall not be used on such connections.

Par. 309. A bottom blow-off cock shall have the plug held in place by a guard or gland. The end of the plug shall be distinctly marked in line with the passage.

Par. 310. The blow-off pipe or pipes shall be extra heavy from boiler to valve or valves, and shall run full size without reducers or bushings. All fittings between the boiler and valves shall be of steel.

Extra Heavy Valves

Par. 311. *a* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 pounds per square inch, each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b Every traction and portable boiler shall have a bottom blow-off valve; when the maximum allowable working pressure exceeds 125 pounds per square inch, the blow-off valve shall be extra heavy.

Par. 312. A bottom blow-off pipe when exposed to direct furnace heat shall be protected by firebrick, a substantial cast-iron removable sleeve or a covering of non-conducting material.

Par. 313. An opening in the boiler setting for a blow-off pipe shall be arranged to provide for free expansion and contraction.

Water Level in Watertube Boilers

Q.—Please send me the official data on the amount of water to carry in watertube boilers. I want this information to tack on the blackboard. We had a low pressure 5-pound steam and vacuum system to our radiators; a high pressure 60-pound to our hot water boilers and drips. It was changed a few years ago to get the knock out of the system, and all hooked into the low returns. It is worse than before the change. High pressure traps blowing, stops circulation in the low and make more noise than ever. Would you advise changing back again?—J. A. K.

A.—The required water level in watertube boilers depends on the type of such boilers. For the Babcock and Wilcox type, Fig. 1, the waterline is at the center of the drum *a*, as

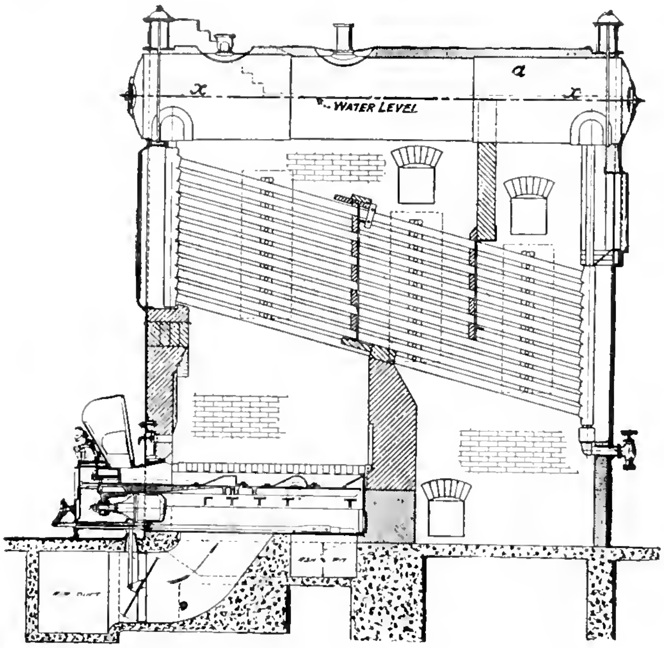


Fig. 1.—Babcock and Wilcox Boiler

indicated along the line *x-x*. Boilers of similar type in which the steam and water drums are horizontal the water level is at the center along the drum axis.

For the Sterling watertube boiler, Fig. 2, the water level is indicated in the three drums, *a*, *b* and *c*. As the drum *b* is higher than the drums *a* and *c*, the water level is lower in the

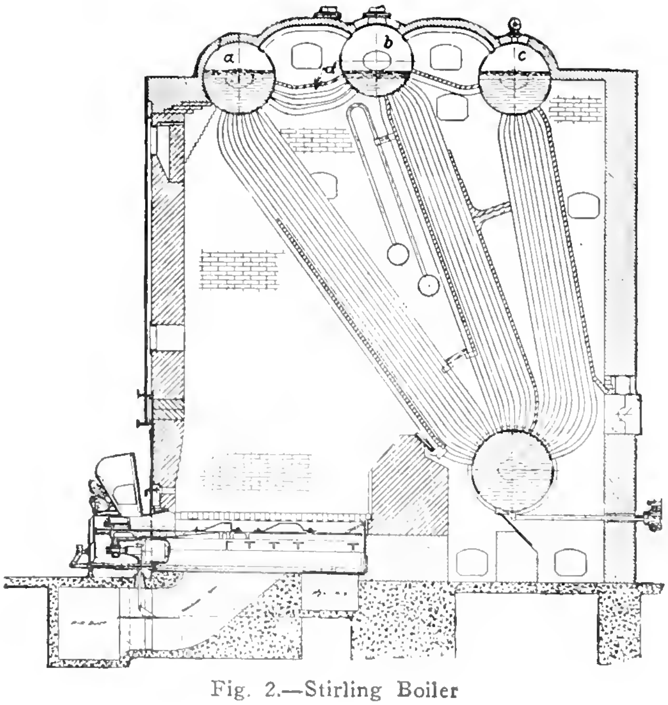


Fig. 2.—Stirling Boiler

drum *b*. The water line in the drum *b* should be at least 2 inches above the circulating tubes *d;* this condition controls the water level in the other drums.

The water level in the standard Heine boiler, Fig. 3, is 2 inches vertically above the center line *a-a* of the drum, as measured at the center of the drum and as indicated in the illustration. This brings the water level at the center of the water gage *b*. In the cross drum type the waterline is at the center of the drum.

Most boilers are so designed that the proper water level is obtained when the water glass gage is half full. There may be exceptions to this, but in any case the maker's specifications should be followed, to locate the water level. After it is established the boiler room attendant must be instructed as to the required water level.

In running the high pressure steam to the returns of the low pressure side the system is reversed and naturally will not work properly. In such a case the circulation would tend to equalize and the steam would blow through the traps and water hammer may result. The radiators would also be affected by the higher pressure.

As we have not complete data on the piping it is difficult to

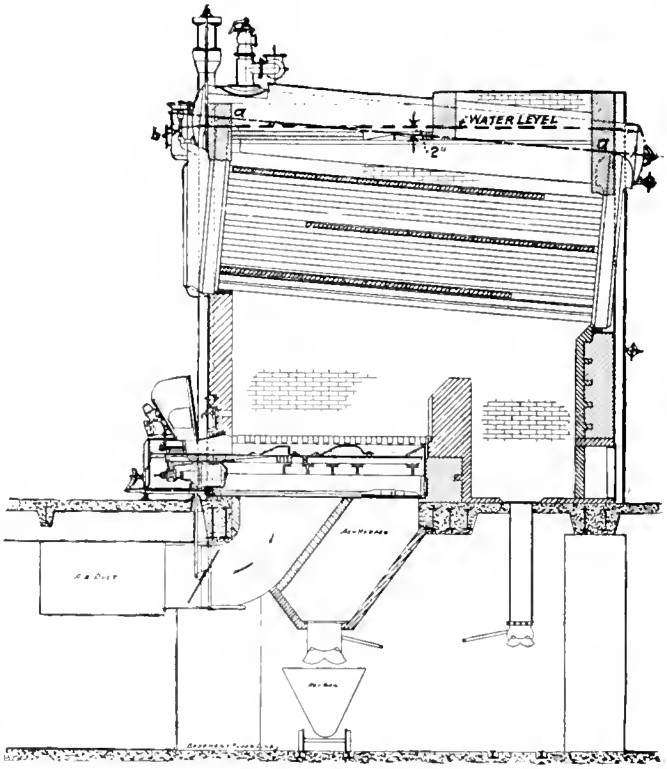


Fig. 3.—Heine Standard Boiler

make definite recommendations, however, if the piping to the radiators is fitted with a pressure-reducing valve and traps used in the return, in conjunction with the vacuum pump, no trouble should arise in that branch of the system. On the high pressure side, if the steam is returned from the hot water heater into the low returns it should pass through a pressure reducing valve and the condensation trapped.

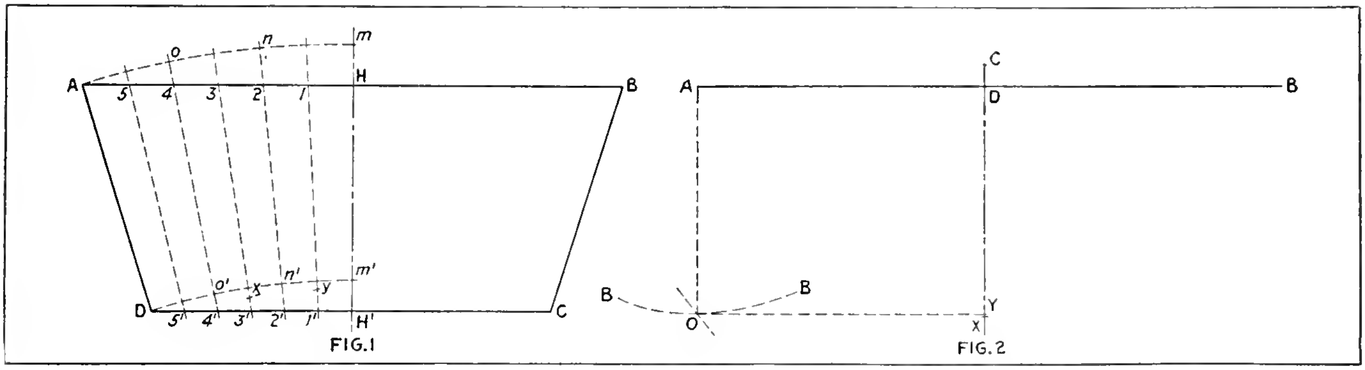
J. P. Moses has been appointed general manager of railroad sales for Joseph T. Ryerson & Son, Inc., with headquarters in the Illinois Merchants Bank Building at Chicago. H. T. Bradley has been appointed manager of eastern railroad sales with headquarters at 30 Church St., New York. H. A. Gray, formerly manager of railroad sales, resigned to enter another field of business.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Wrapper Sheet Camber Layout

I HAVE seen many different methods used for obtaining the camber of a ladle wrapper or tank, stack or other conical course where the conical height is too great to permit layout with a sweep and it is wished to avoid triangulation. Some of them are theoretically exact but involve awkward constructions which make them impractical while the "snap" methods are not to be relied on for heavy plate work where accuracy is desirable. I myself have a partiality for accuracy in laying out work and I believe the method I submit herewith is superior to any other since it is both simple and absolutely exact. Once understood, it is easily used and always insures a true shape as may be easily proved by working up a short beveled cone as shown and checking the curve with the trams.



Method of Obtaining Camber of a Ladle Wrapper, Tank or Stack

Construct *A-B-C-D*, Fig 1, making *A-B* and *D-C* equal respectively to the large and small circumferences of the conical course (or half circumferences if desired). Illustrating only one-half the stretch-out, divide *A-H* and *D-H'* into the same even number of equal spaces. Through the corresponding points thus found draw lines as 1-1', *n*-2', etc. Set the trams to *A*-5' and using this distance as a radius from 5' as a center locate the point *o* on the line *o*-4': similarly from *o* as a center locate the point *x*; from *x* as a center locate *n;* from *n* as a center locate *y;* and from *y* as a center locate *m*.

Set the trams to the slant height of the course—in this case *A-D* is used—and from the points *o*, *n*, and *m* locate respectively *o'*, *n'*, and *m'*. Through points *A*, *o*, *n* and *m*, draw a curve for the large circumference and in the same way points *D*, *o'*, *n'* and *m'* determine the curve of the small circumference.

Finally if the camber is considerable, measure off on the curves thus found the exact circumferential lengths desired which completes the lay-out. The same method may with slightly different procedure be used to construct a true arc of a circle of any diameter having known as in Fig. 2 the chord *A-B* and rise *C-D*.

Extend *C-D* to any convenient length as *C-X* and from *A* as a center using *C-X* as a radius strike an arc as *B-B*. From *C* as a center with *A-X* as a radius strike an arc intersecting *B-B* as at *O*.

The points *A* and *O* thus determine a true radial line *A-O* and after drawing *O-Y* perpendicular to the centerline *C-X* we may proceed with the half figure *A-D-Y-O* in the same manner as with Fig. 1. In this case the point *C* may be used to check the exactness of the work since it should correspond with the last point found as *m* in Fig. 1.

If carefully followed, the procedure of Fig. 1 will always insure fair holes regardless of the difference between the large and small diameters and is much quicker than development by triangulation.

Houston, Texas — R. L. Phelps

A Plea for Better Supervision of Boilers

CONDITIONS as outlined to us by Mr. C. W. Carter in the July issue of The Boiler Maker (page 214) regarding locomotive boiler inspection are not very reassuring to those entrusted with the operation of engines or to the public at large. We have heard of such conditions and, as Mr. Carter in various issues of The Boiler Maker has given us articles that were both interesting and instructive, some attention should be given to his remarks. The condition exists, what is the remedy?

It is true, the shop boiler inspector does not have to pass an examination, but he should be compelled to do so, an examination along the same lines as the state codes require from their inspectors. Then he should have had not less than five years' experience as a boiler maker apart from his apprentice service. Having these necessary qualifications, there is only one more thing necessary, apart from good judgment, and that is, back-bone.

Our Federal laws put it squarely up to the inspector, not to his foremen or his master mechanic and, if he reports defects that are dangerous, or come within the meaning of the law as so written, he can refuse to sign the forms and that is where the back-bone is required.

Mr. Carter does not state what railroad he is working for, but at the local shops of the Baltimore and Ohio Railroad where I am employed such conditions do not exist, traffic is heavy, the lake coal season is in full swing, but every one of us in the boiler department takes pride in the knowledge that the boilers that come under our care are as safe as the day they were built.

We have a competent boiler inspector and, when he reports defects that tend to weaken the boiler, repairs must be made before he will sign the forms and, in all fairness to his superior officers, there is never any trouble on that account. I suggest as a remedy for such conditions as outlined by Mr. Carter:

1st. Competent inspectors—with back-bone.

2nd. Supervising officials, with common sense and the willingness to cooperate with their boiler inspector.

Lorain, O. Joseph Smith.

In a Pinch

How many times through carelessness have staybolts marked on one end to be renewed been marked wrong on the opposite end?

Just such a condition occurred on an old-type locomotive boiler, which required much more consideration than merely renewing an extra staybolt to remedy the mistake. The boiler in question had the lower half set of flues renewed, defective staybolts removed and some minor firebox repairs done while in shop. When the hydrostatic test was applied to see that all the work was tight, the inspector found a staybolt leaking through the tell-tale hole. It was located on the center of the throat sheet, top bolt, and was marked outside to be renewed but never marked on the opposite end in the firebox. The foreman after receiving the report sent a three-year apprentice, helper and an acetylene burner to renew the bolt. This bolt was burned outside where marked, but, instead of the defective staybolt being marked, an eye bolt of a throat brace was marked and burned out on the firebox side which was located directly above the defective staybolt that was burned outside on the throat sheet.

After all the scheduled shop work was done, and the engine about ready to be put into service, it seemed out of the question to remove the dome cap, throttle chamber and standpipe and five or six rows of flues down through the center of the boiler to replace the eye bolt that was burned out in the firebox by mistake.

As the boiler would be due for a complete removal of flues in between one and two years, and a possible renewal of the back flue sheet, it was decided to burn a 5-inch diameter piece out of the back flue sheet where the eye bolt was centered. The pin, nut and cotter were then burned out, and the eye bolt removed through the 5-inch opening made in the back flue sheet.

A new eye bolt and pin with just a cotter pin hole in it was then made. Before applying same, the opening in the back flue sheet was chipped to a 45-degree angle. After this was done and the eye bolt applied, a piece of firebox steel ½-inch by 5-inch diameter was cut and the edge turned to a 45-degree angle (allowing enough opening for electric welding) and a 13/16-inch hole drilled in the center for the eye bolt, which was tapped out 1 inch with a 12-thread tap to fit the eye bolt thread. The plate was then screwed into place with a chisel or pointed tool and hand hammer. A steel clamp ¾ inch by 2 inches by 8 inches with a 1⅛-inch hole drilled in the center and a special 12-thread nut was made and temporarily applied to hold the tension of the brace, eye bolt and plate in place while the plate was tack-welded in several places. The nut and clamp were then removed, the plate homogeneously welded, the eye bolt burned off leaving enough for the head which was then driven with a light pneumatic hammer and bobbing tool.

The fractured or original staybolt with right and left adjacent bolts were renewed and the boiler hydro tested O. K.

Jersey City, N. J. T. P. Tulin

TRADE PUBLICATIONS

Electric Steel Castings.—A group of bulletins outlining the process of manufacturing electric steel castings and their application in industry has been collected in binder form for distribution by the Nugent Steel Castings Company, Chicago, Ill., formerly the Electric Steel Company.

Boiler Tubes.—An announcement of the New York boiler tube supply service of B. F. Keating Company, New York city, has recently gone out to the trade. Complete stock of steel, lap welded and seamless charcoal iron tubes, as well as fittings, valves, cocks and plumbing supplies are maintained in the New York district. The card also includes a number of reference tables giving tube data.

Modern Furnace Building.—The Jointless Fire Brick Company, 9899 Clay Street, Chicago, is offering to engineers and power plant operators a booklet which tells the complete story of the building of monolithic furnace linings. It shows how boiler furnaces, circular furnaces, pit type brass furnaces and other furnaces may be lined with this jointless furnace lining. Illustrations showing how forms for special shapes, like front door arches are made, are frequent.

Control Relays.—Control Relays, to be interposed between the circuit breaker solenoid and control switches are described in bulletin No. 47672 issued by the General Electric Company, Schenectady, N. Y. The relays described are known as the instantaneous control, type PB-53 and the hesitating control, type PB-54. These relays are used for the remote control of circuit breakers when it is undesirable to have the control current pass through the control switch.

Hydraulic Riveters.—Riveters, hydraulically actuated, applicable to all kinds of ship, plate, tank and boiler work, are described in a bulletin issued by the Hanna Engineering Works, Chicago, Ill. Illustrations and descriptions for riveters, both regular and special type, are given in sizes from the 6-inch reach, 8-inch gap, 15-ton capacity, forged nose riveter to the 126-inch reach, 18 to 24-inch gap, 80-ton capacity, boiler riveter.

Boiler Tube Cleaners.—A conveniently indexed catalogue descriptive of boiler tube cleaners has been sent out by the Roto Company, Hartford, Conn. Some of the sections into which the catalogue is divided deal with cleaners for watertubes, arch tubes, fire tubes, with condenser tube cleaners, various type motors used, accessories and repair parts. Charts of savings possible with Roto cleaners and a method of computing fuel savings possible with clean tubes are included.

Shop Trolleys.—A trolley folder has just been issued covering the new Yale trolleys. It is the first piece of literature to be issued on this equipment, and contains, in addition to detailed descriptions of the plain and geared types of the new Yale steel plate roller bearing trolleys, a description of the new Yale cast-iron trolleys. Incorporated in it are details of interesting tests to which the new steel plate trolley was subjected, and a complete list of the material-handling equipment manufactured by the Yale & Towne Manufacturing Company, Stamford, Conn.

Steam Driven Compressors.—The Ingersoll-Rand Company, 11 Broadway, New York, has just issued a 36-page bulletin describing "Imperial" type XPV Steam Driven Air Compressors. This compressor is built in a number of different types and sizes; standard two-stage machines for 100 pounds discharge pressure, range from 246 to 4,150 cubic feet per minute piston displacement; single-stage compressors are built for furnishing air up to 50 pounds discharge pressure. One of the outstanding features of type XPV compressors is the automatic cut-off governor.

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William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

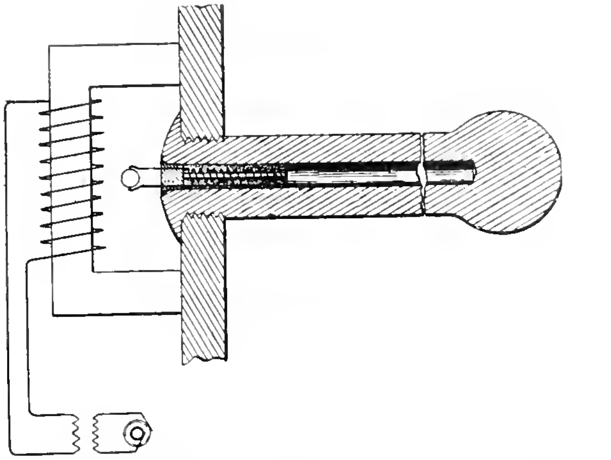
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,455,836. MEANS FOR TESTING STAY BOLTS IN BOILERS. JOHN ROGERS FLANNERY, BENJAMIN E. D. STAFFORD, AND ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF DELAWARE.

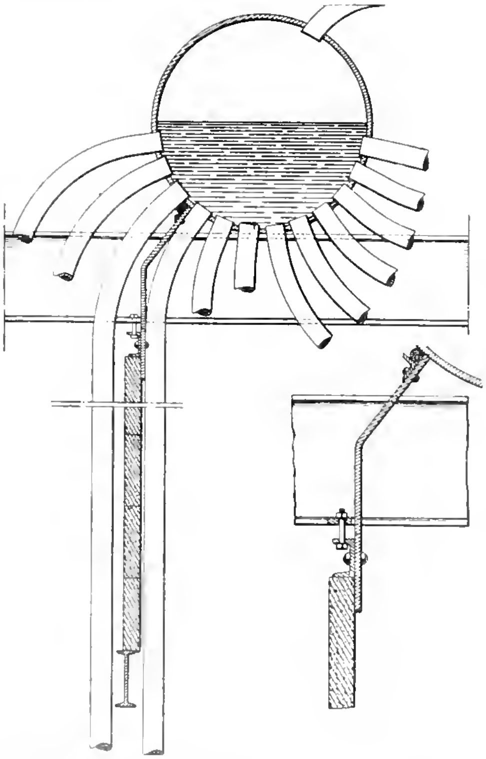
Claim 1. The combination with a stay bolt having a bore, of a coil within said bore, a material within said bore and contacting with said coil,



said material being such as will by contact with moisture cause severance of the wire of said coil, a translating device included in circuit with said coil, and means for inducing an electric current in said coil. Three claims.

1,457,282. BAFFLE FOR WATER TUBE BOILERS. EDGAR KIDWELL, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO KIDWELL BOILER COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

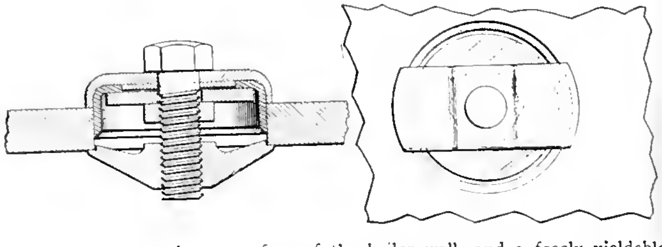
Claim 1. In a boiler of the series drum and tube type, the combination with a rearward drum and a rearward bank of water tubes extending



therefrom of a baffle element associated with said tubes, said element comprising a tile structure spaced below the drum and a metal member occupying the space between said structure and the drum and shaped to lie in the upper curved space between adjacent rows of tubes, a rigid support below the drum, and a connection between said support and the plate member for vertically adjusting said member to force its upper edge into close contact with the opposing wall of the drum. Three claims.

1,456,314. BOILER PLUG. FREDERICK E. KEY, OF ST. LOUIS, MISSOURI.

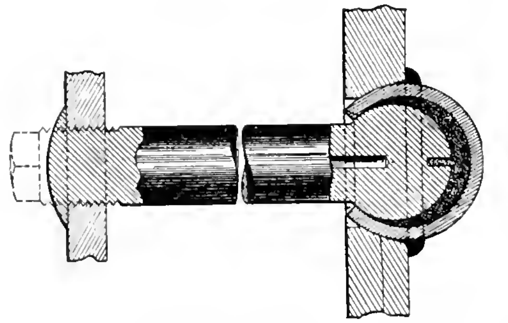
Claim 1. A boiler plug comprising an inside anchor adapted to engage the inner face of the boiler wall to which the plug is applied, a tension member secured to and extending outwardly from said inside anchor, and a closure comprising a packing holder secured to said tension member and



adapted to engage the outer face of the boiler wall, and a freely yieldable packing ring having an annular outer marginal portion secured to said packing holder and a free, flexible annular inner marginal portion conforming to and adapted to be seated against the wall of the opening to be closed, said packing ring being exposed to receive the outward pressure of the fluid, so that the fluid pressure will force said annular marginal portions into engagement with their seats and at the same time place the anchored tension member under tension. Two claims.

1,455,837. STAY BOLT STRUCTURE. JOHN ROGERS FLANNERY AND ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS, BY MESNE ASSIGNMENTS, TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF DELAWARE.

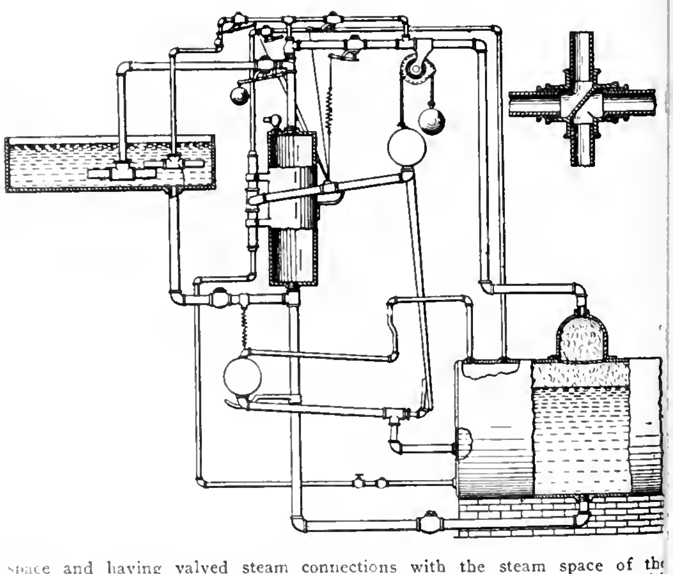
Claim 1. In a stay bolt structure, the combination with a boiler sheet having an opening of a combined bearing member and closure having an



initial universally movable mounting on the boiler sheet coincident with said opening and adapted to permanently enclose the head of a staybolt, a staybolt having a head mounted in said member, and a weld securing said combined bearing member and closure to the boiler sheet. Two claims.

1,456,722. BOILER-FEED WATER SYSTEM. GEORGE W. COPE, OF OIL CITY, LOUISIANA.

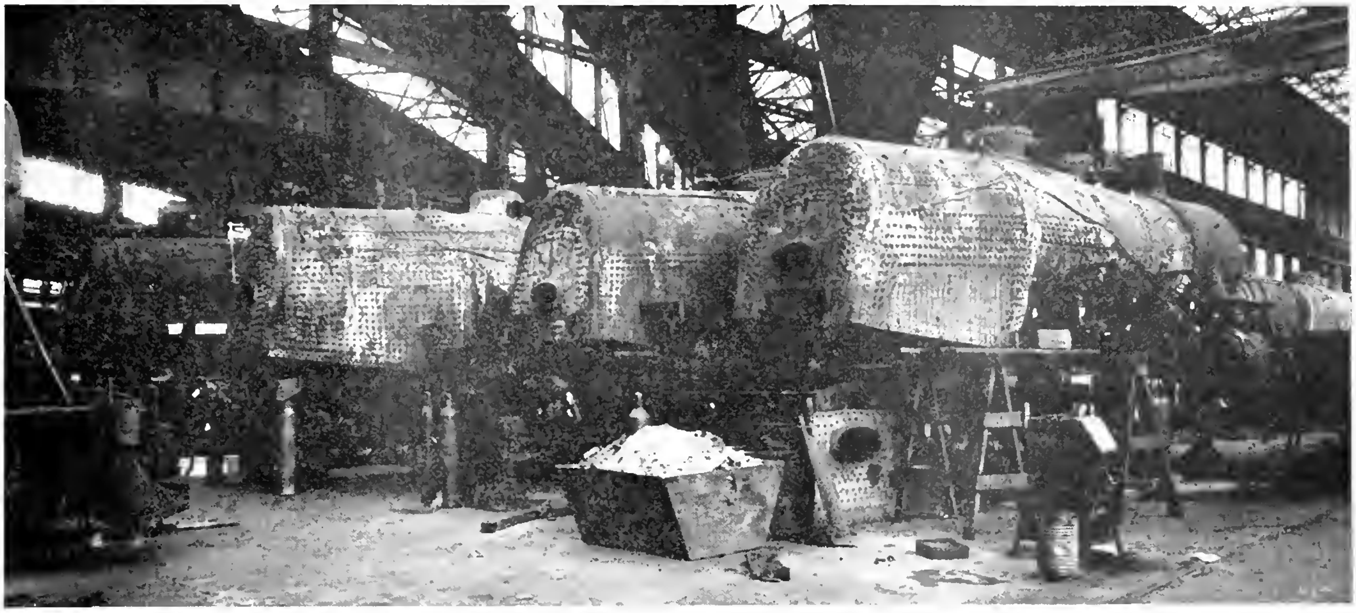
Claim 1. In a gravity feed water system for steam boilers having a charging tank, said tank situated above the boiler water level and having a valved water inlet and a valved water connection with the boiler's water



space and having valved steam connections with the steam space of the boiler, an air inlet and a valved steam outlet combined with means for operating the valves of said valved steam inlet and outlet means for gradually establishing boiler pressure upon the water in said tank to thereby prevent the high speed flow of a large volume of steam upon the water in said tank and prevent a water hammer, said means comprising essentially a primary steam inlet, a valve in said primary steam inlet, means connecting the valve with the valve operating means, a secondary steam inlet, a valve in said secondary steam inlet, and an elastic connection connecting the valve of the secondary steam inlet with the valve operating means. Seven claims.

The Boiler Maker

SEPTEMBER, 1923



Battery of Boilers on Special Trestles for Repair

Repairing Locomotives in a Contract Shop

The extensive locomotive repair program of the present year has made it necessary for many railroads to send heavy repairs beyond the capacity of their facilities to contract shops having the equipment and organization for carrying on such work. The following article outlines the methods employed by one contract repair shop that was built up around a war-time ordnance plant. Special emphasis is placed on the type of boiler repairs handled and the special methods employed for boiler work.

FOLLOWING the war, the Morgan Engineering Company, manufacturers of overhead cranes and other heavy mill equipment at Alliance, Ohio, found itself with a large plant unequipped except with cranes, that had been built for the manufacture of heavy ordnance. The demand for outside capacity for heavy locomotive repairs, which developed after the drastic curtailment of mechanical department forces on the railroads in 1921, led to consideration of the utilization of this plant as a contract locomotive repair shop. Accordingly, after a satisfactory form of contract had been worked out, which required the development of a base sufficiently detailed to cover all usually performed operations while still retaining a degree of flexibility which would take care of all work the need for which becomes evident only after a locomotive has been stripped, an organization was developed and operations started.

Layout and Arrangement of Plant

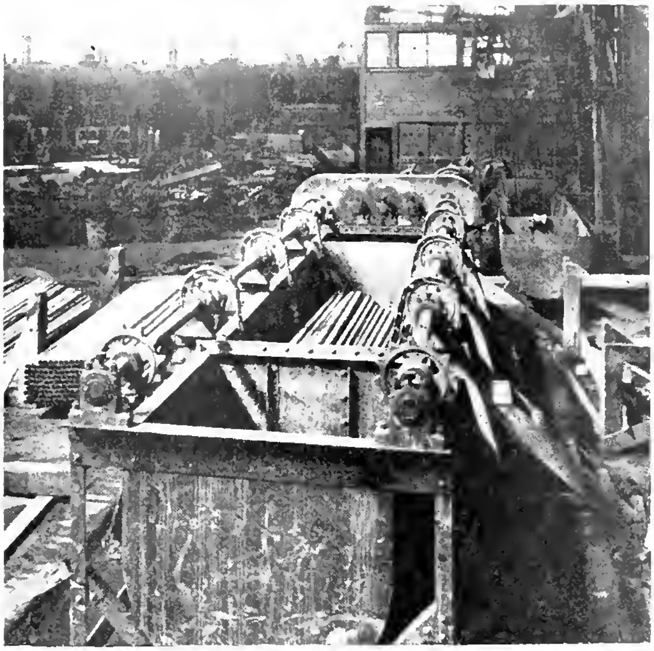
The first engines were repaired during the latter part of 1921. Owing to unsettled conditions, however, operations did not actively get under way until the fall of 1922.

The building consists of what may be termed a header bay 840 feet long by 90 feet wide, from one side of which opens a series of parallel bays extending out at an angle of about 34 degrees from the header bay. As these bays all terminate in a single end wall, they vary in length from about 115 feet in the case of the short bay opening into the header bay nearest its southern end to about 530 feet for the east bay opening from the north end of header bay. The building is of steel frame construction with brick curtain walls at the lower portion of the sides of the building, above which there is an unbroken expanse of steel sash. Additional light is admitted through glazed openings in the roof.

This building is located in an enclosure adjoining the south end of the main plant yard, in which its manufacturing operations are conducted. The two enclosures are separated by a street, but communication is maintained between them by continuous industrial tracks and by the plant roadways, over which material is transported to and from the locomotive shop by motor truck.

Features of the Erecting Shop

The most interesting feature of the locomotive repair shop is the method of handling erecting shop work. The erecting



Small Tubes Being Cleaned in Wet Rattler

shop occupies the long bay from which open the parallel bays and has floor space for 70 locomotives in addition to those on the stripping and wheeling tracks. This building originally was not equipped with pits and had but two tracks running through it, one along either side. With practically no changes in the floor construction it has been adapted to effective use as a locomotive erecting shop by the portable structural steel stools on which the locomotives are supported. These are of sufficient height to permit work to be done under the engines after they have been stripped and placed on their "spots" without the necessity of floor depressions and with better lighting under the locomotives than normally found where they are set over pits.

The only change in this shop has been the construction of pits along the track on the side from which the parallel bays open, which is used as a wheeling and finishing track As will be seen from the illustrations, the locomotives are placed on their spots in a staggered formation so that the tubes may be removed from the front end of one locomotive without interference from the locomotive next in front of it.

Arrangement of Boiler Test Blocks

At the north end of the erecting bay is what is known as the testing block. Here the first spot in each of the four rows between the stripping and wheeling tracks, is devoted to the making of hydrostatic tests.

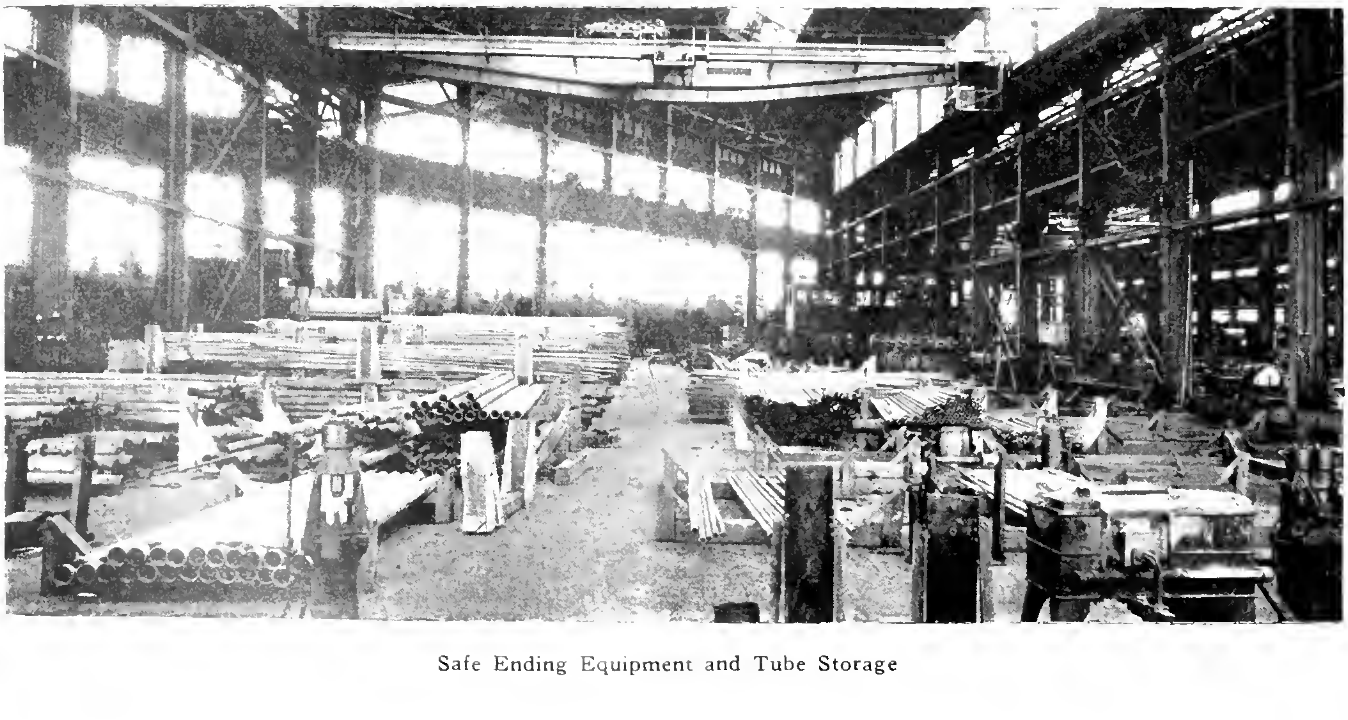
The erecting bay is served by three Morgan cranes, all operating on the same ways. The capacity of the first toward the south end of the shop is 75 tons, of the next, 40 tons, and of that toward the south end of the shop, 25 tons. Slings are used at both ends of the locomotives when lifting with the cranes. In moving a locomotive about the shop, the sling from the 75-ton crane is placed around the barrel of the boiler just ahead of the firebox, while the 40-ton crane lifts the front end. The stripping track accommodates six locomotives. Here the engines are completely stripped, the parts removed to the lye vat, cleaned and delivered to the machine shop by the stripping gang. After stripping, the locomotive is unwheeled and moved to the "spot" assigned to it, where the boiler, frame and cylinder work is done. When ready to be assembled, the boiler and frames are moved by crane to the wheeling track and from here through the several assembly operations until the locomotive has been tested and accepted.

Boiler Shop and Equipment

A series of bays opening into the erecting shop is arranged to accommodate the various repair departments. Like the erecting shop, each of these bays is well equipped with overhead cranes, and a comparatively small amount of special equipment has been installed.

Starting at the south end of the erecting shop, the first of these bays is occupied by the flanging department. This bay is served by one 40-ton crane and is equipped with an annealing furnace, three open fires and one hand and one pneumatic flanging clamp.

The next bay is occupied by the flue shop, the arrangement of which is shown in one of the illustrations. This bay is served by one 10-ton and one 40-ton overhead crane, and is equipped with three welding sets, each consisting of a



Safe Ending Equipment and Tube Storage

Draper hammer and a Ferguson furnace. One of these is used on superheater flues and the other two on tubes. These facilities are arranged along the south wall of the bay. Two flue rattlers of the wet type have been placed on the shop floor at the east side of the bay near the erecting shop, one of which can be loaded and unloaded by crane, while the other requires manual loading. The flues are tested under 100 pounds air pressure, submerged in water.

Tubes Stored in Sets

Owing to the practice of the Morgan Engineering Company of taking in as many locomotives as the available erecting floor space will permit, irrespective of the number on which work is actually being performed, a large number of sets of tubes are stored in the flue shop. Instead of progressing from one operation to another with no intermediate handling, the practice is to complete each operation on each set of tubes, after which the entire set is moved by crane to the station of the next operation.

The outer end of the third bay is occupied by the boiler shop for laying out firebox sheets. The remainder of the bay is devoted to the repair of detail fittings. On the west side are located a battery of six small engine lathes, a small shaper and one Lassiter-Milholland staybolt machine. The latter machine gives an output of 350 staybolts, turned and threaded, in 12 hours. This bay is served by one 10 and one 25-ton crane, the heavier crane being located toward the erecting shop end.

The next bay to the east, which is approximately 90 feet wide, is devoted to heavy boiler work. Here the work on all boilers requiring new fireboxes or back ends is completed before the boilers are returned to the erecting shop. This department is provided with one vertical and one horizontal punch, a vertical shear and a radial drill for drilling tube sheets. The shop is not equipped with a heavy bending roll and all firebox or boiler shell sheets requiring bending are sent outside. On the east side of this bay is located a testing block for superheater units. Here all units are tested and inspected as they are removed from the locomotive, to locate those requiring renewal. After the units have passed this test, they are stored in sets in the next bay, so piled that all header joints are accessible. The joints are ground with a portable machine as they lay in the pile.

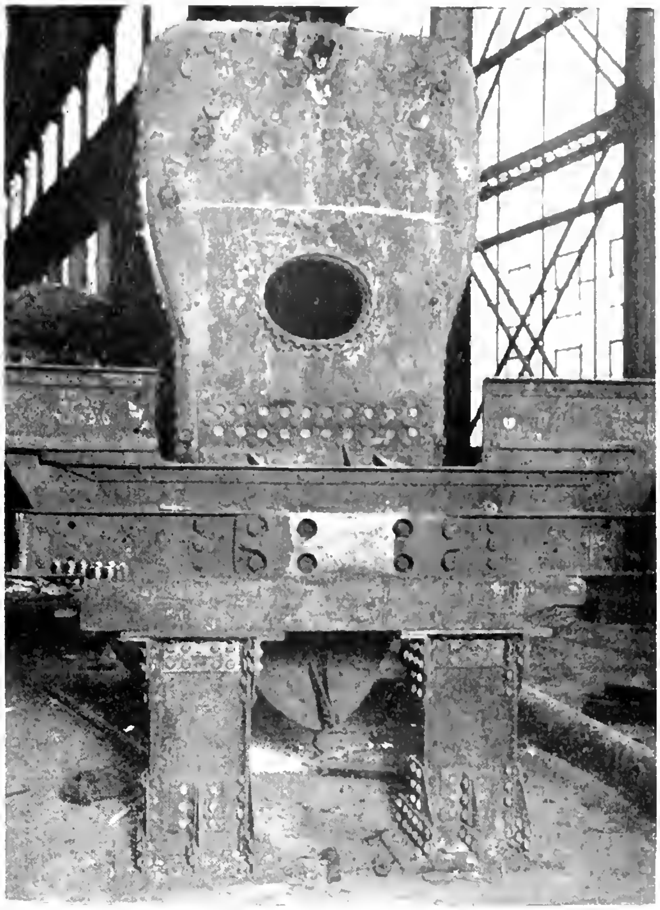
The outside bay is about 50 feet wide. It is devoted to engine truck repairs, cabs, and superheater unit storage. Space is also provided in this bay, just off the erecting shop, for lagging storage and reclamation. No provision is made for remolding broken lagging. Broken material is pulverized and tempered for bulk use in plastic form.

This bay, which is equipped with two 10-ton cranes, was formerly used as a tender repair shop. This work, however, has now been transferred to one of the buildings in the manufacturing plant, which was formerly occupied by the iron foundry.

Details of Boiler Repair Work

When a boiler requires a new firebox it is brought into the bay devoted to boiler work where the firebox is laid out, punched and sheared, flanged, fitted and applied to the boiler. All staybolts and crownbolts are applied in this bay, in fact the boiler is completed with the exception of installing the flues.

As work is carried out at the plant for about ten different railroads, it is impossible to standardize the methods of performing firebox repairs. Such work must be done in accordance with the various standards of the railroads with which the plant has contracts. All welding on the fireboxes, however, is done by the electric arc process. On some fireboxes, for example, the railroads specify that the welding be done on the inside and reinforced on the outside. Other roads specify that the firebox be welded complete, while still



Special Type Trestle for Carrying Boilers During Repair

others require that the door sheet and back flue sheet be refitted with the exception of the waterlegs which are welded.

Some railroads have the flues electric welded in the firebox, others have the superheater flues, and the small flues between, welded in both ends. Others do not have the flues welded until after the engines have been in service for some time. The flues are all electric welded on the assembly track.

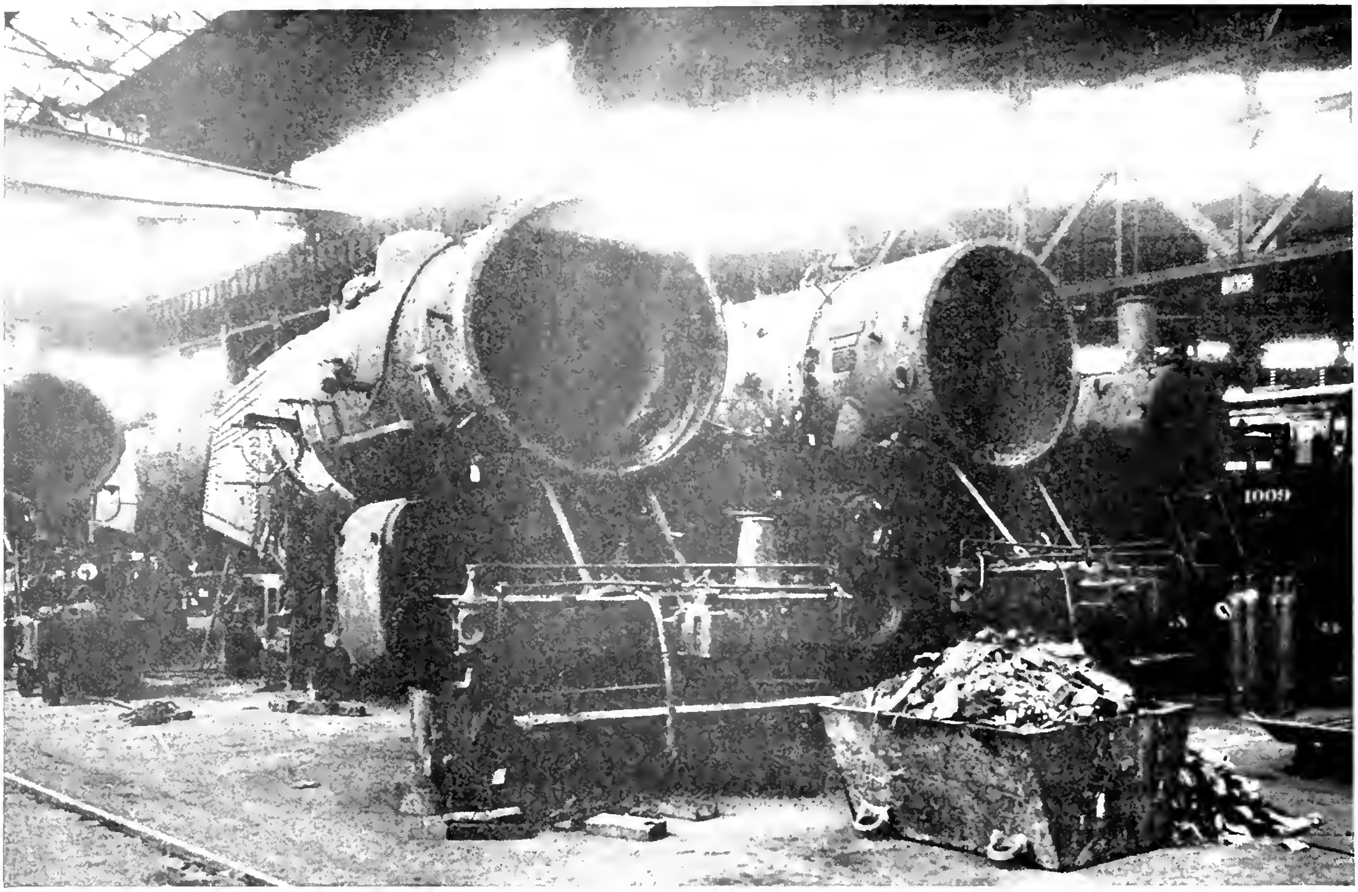
In removing flues a motor attachment has been developed for cutting the flues in the front flue sheet. Where a new back flue sheet is required, a section of it is taken out and the flues removed through this hole.

Flanged work is all done by hand, as each railroad having work done in the shop uses different types of boilers and since there are so many different types on a single order it is not practical to make dies to press out flue sheets and door sheets. A special rig used in drilling staybolts utilizes a counterweight attachment for raising and lowering the motor and also for raising and lowering a plank which acts as an "old-man." One man with this rigging is able to drill an average of 60 bolts an hour.

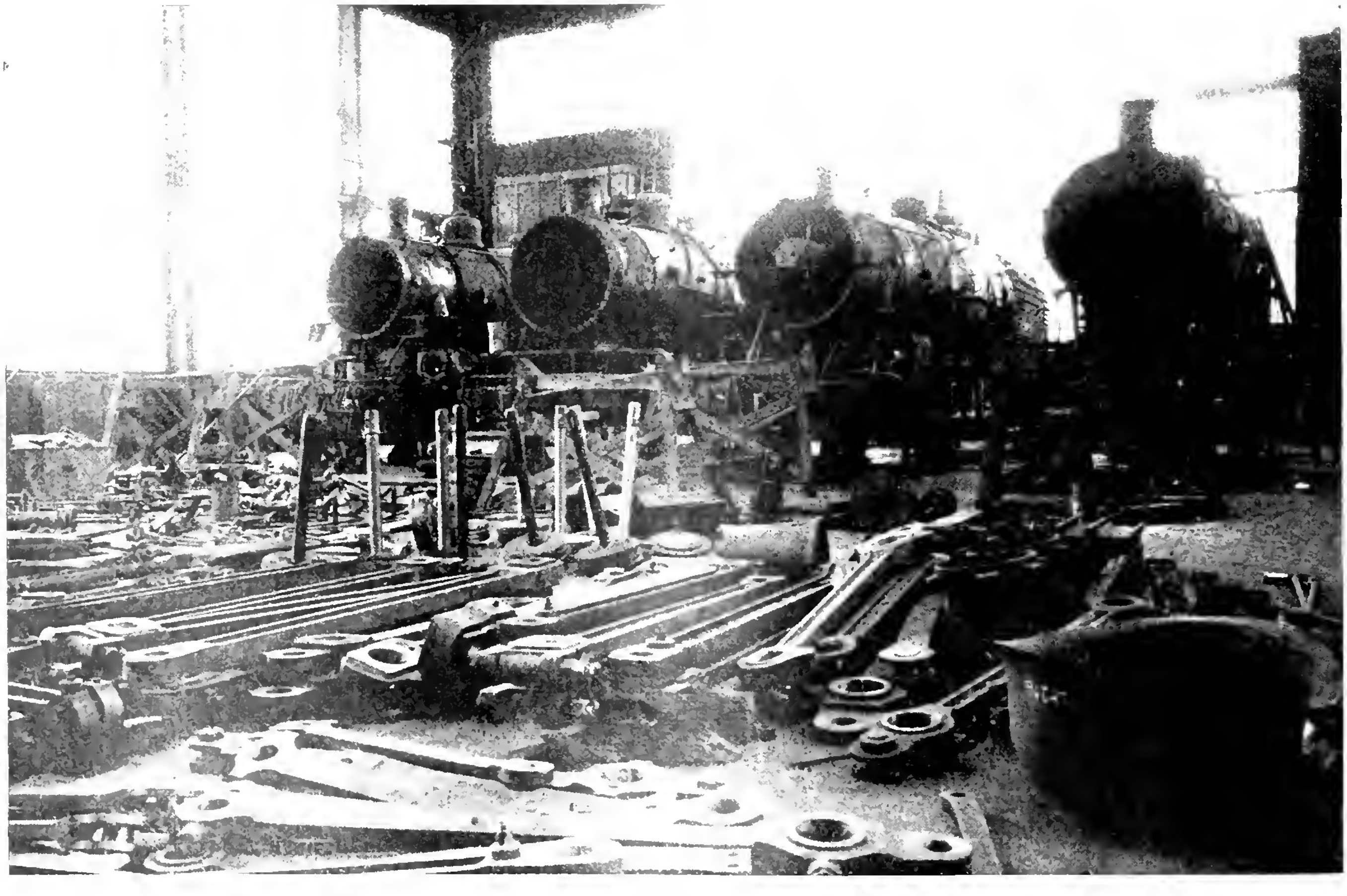
Summary of Work Performed in the Boiler Department

On one order of 50 Mikados which has been in the shop for a comparatively short time, 20 have already been rebuilt. The boiler repairs on these locomotives call for new back flue sheets, 3/4 door sheets, 3/4 back heads, 3/4 inside side sheets. These boilers have been changed from hand fired to stoker fired and a complete installation of flexible staybolts made.

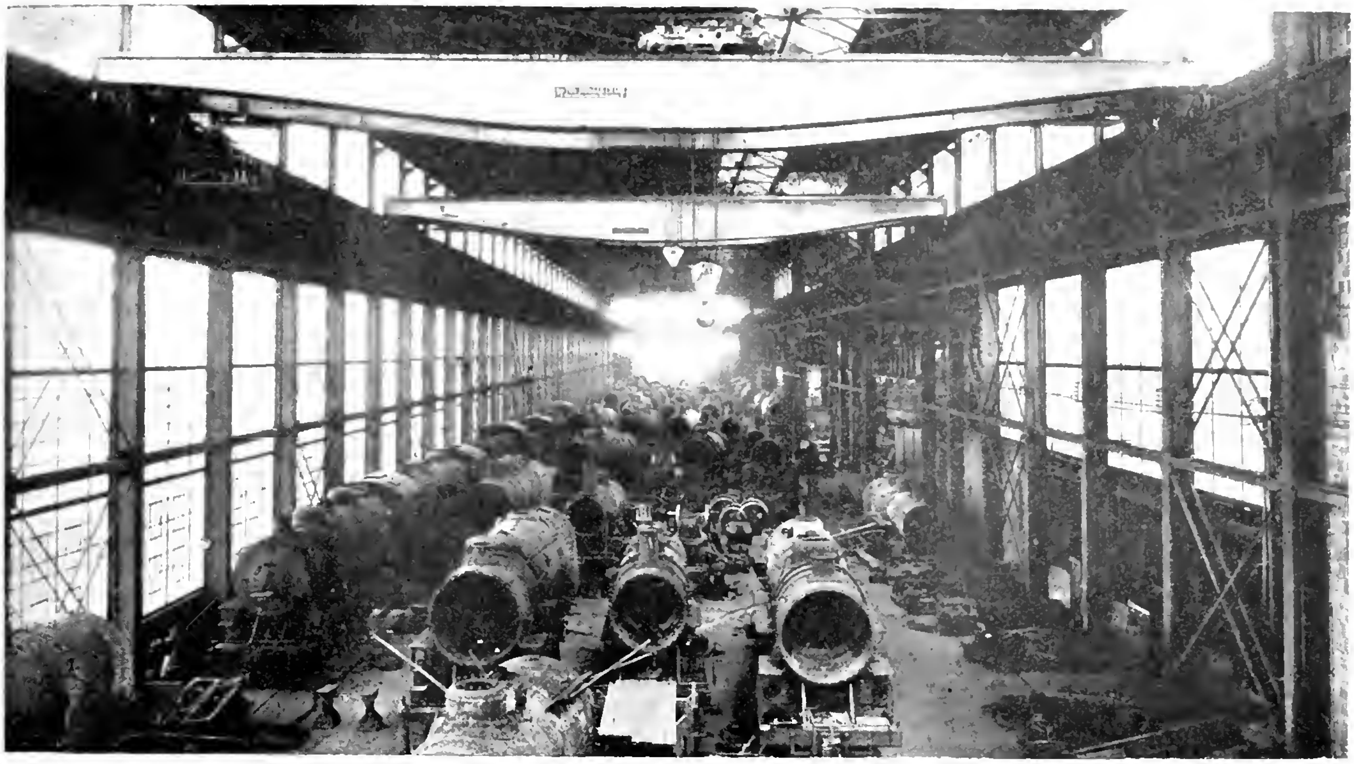
The firebox on this type of Mikado is 75 1/4 inches wide and 108 1/8 inches in length having a grate area of 56.5 square feet. The firebox has a heating surface of 250 square feet. The boiler contains two hundred and fifty-seven 2-inch



Final Clean-up and Boiler Assembly in Erecting Shop



A Final Test Under Steam is Given the Locomotives in this Department



General View of Work in the Erecting Shop

flues and thirty-six superheater flues 5⅜ inches in diameter. The 2-inch flues have a heating surface of 2,745 square feet and the superheater flues, a surface of 1,033 square feet, making a total heating surface of 4,008 square feet. The total weight of the engine is 287,000 pounds not including the tender. The tender, loaded, weighs 153,900 pounds in addition.

On another order of 10 Mikados, the fireboxes have been installed complete with combustion chambers. These locomotives have a tractive power of 60,800 pounds. The weight of the engine, not including the tender, is 322,500 pounds. The tender weighs 168,900 pounds, the total weight ot engine and tender being 491,400 pounds; the firebox has a heating surface of 283 square feet; the heating surface of the tubes is 3,768 square feet; the superheater heating surface is 845 square feet or a total heating surface of 4,051 square feet with an equivalent heating surface of 5,318 square feet. The firebox is 84¼ inches by 114⅛ inches. The combustion chamber is 20 inches by 80 inches diameter with a grate area of 66 square feet. The boiler barrel is 96 inches in diameter.

Several engines of the consolidated type and the Pacific type have been converted from coal to oil burners in addition to changes in the boiler which necessitated a complete change and rearrangement of tenders.

Inspection Department

Each railroad has its own inspection organization and both the Morgan Engineering Company and the railroad's inspectors are provided with complete sets of drawings of the locomotives passing through the shop. Much of the material, particularly brass and iron castings and all special fittings are furnished by the railroads. Each railroad is provided with its own storehouse in charge of its own storekeeper, these stores being housed in small buildings of frame construction adjoining the south wall of the parallel bays.

Shop Organization

To a large extent the employees engaged in the locomotive repair work, aside from those in the manufacturing department, are semi-skilled men rather than fully qualified mechanics. The work is therefore specialized in all departments under the jurisdiction of the superintendent of the locomotive repair department.

In the erecting shop most of the gangs are small and highly specialized, working under gang leaders. All welding and cutting work is handled by one gang which is in charge of a foreman. The same organization idea is carried throughout the plant. In the case of the boiler department about 80 percent of the men are semi-skilled specialists. In this department one gang does nothing but remove sheets which are to be renewed. The sheets are then taken to the laying out department where new ones are laid out, punched, sheared and made ready for the fitters. The fitting gang then assembles the sheets ready for the welders and riveters. The welding is performed first, after which the remaining joints are riveted and calked. The staybolts are then applied followed by the crownbolts, each operation being performed by a separate gang.

The boiler is then sent to the test block and washed out and the flues applied after which it is given the hydrostatic test. It is then taken to its specified spot on the erecting floor where a miscellaneous gang cleans up any work that develops as a result of the test. The testing block gang takes care of all boiler work which develops during the running tests after the locomotive has left the shop.

During the month of June there was an average of about 1,000 men actually working on locomotive repairs approximately 250 of which were boiler makers and helpers, 300 were employed in machine and forge departments and 450 on the erecting floor on air brake repairs and in the tank shop. From 725 to 750 of these men were located in the departments housed in the locomotive shop building.

During the month of June the output was 36 locomotives, none of which required less than Class-3 repairs, many of them running very heavy. Of the 40 engines completed during the month of July, two required complete new back ends; 7 required new fireboxes; 20 required new back tube sheets, door sheets and inside side sheets, the remaining 11 called for either new back flue sheets or new side sheets and patches.

Boiler Inspection Work In Malaya

By George Cecil

THERE are pleasanter spots than the Malay Peninsula, or the Federated Malay States, as it is known officially, in which to earn one's living as a boiler inspector, for the muggy, sultry climate is ever trying, even in the (reputed) "cold weather," and there is little of that light and agreeable side of life which awaits the white man in other British colonies. True, the mountain sanatorium is at the disposal of those who, rendered liverish and run-down by days and nights of sweltering heat need a change. There the exile breathes the finest air in all the world, and roses, grown in the hotel garden, adorning the vases on the dining room table, gladden his sight at breakfast time.

But the "hills," alas, only are for the well-to-do; for prosperous merchants and highly-paid officials, who are provided by the British government with employment which takes them a few thousand feet above sea level. The boiler inspector remains "down below," as the "plains," are termed, his work keeping him there month in and month out. He is granted periodical leave of absence, being entitled to thirty days a year, and he is treated generously enough where sick leave is concerned. The unfortunate man's pay is, however, comparatively small, seldom can he afford to sample the mountains. His means only admit of a short sea voyage to perhaps Calcutta or Rangoon, and a sea voyage in the heat of the Indian Ocean has its disadvantages. Only in the monsoon season is the air at all cool, and that lasts but a few weeks; besides, there are frightful storms—none more devastating. The invalid may find himself in Davey Jones' locker.

Retired on Pension

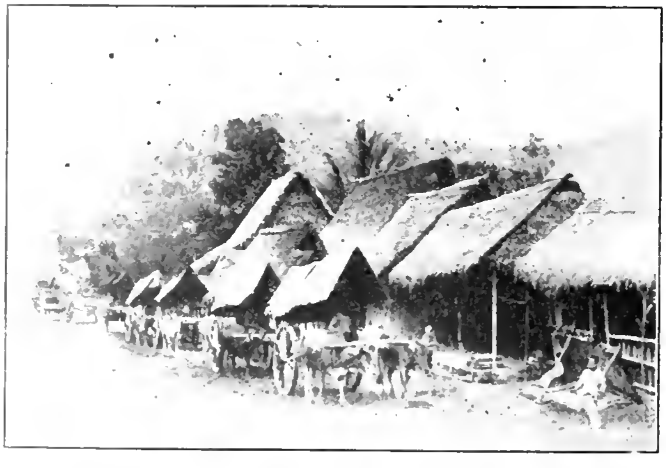
Yet the expatriated one might be worse off. Being a government servant he is entitled to a pension after some twenty-five years' service in the sweltering Federated Malay States.

Not a large pension, little more, in fact, than a decent competence. He draws his pay with clock work regularity on the first of each month, and the traveling allowances are based on a scale which leaves a margin of profit. Indeed, a boiler inspector who lately retired admitted that disagreeable though he had found his tours of inspection, they had enabled him to put by something worth having in way of a nest egg. Having long outgrown his original hankering to take leave "Home" (all well-regulated exiles speak of England as "Home"), the pensioner leads a contented life in a mountain bungalow, taking in "paying guests" and turning a pretty penny over this commercial hospitality. Scotch is he!

Another retired boiler inspector, who enjoys a ripe old age, is to be found in Malacca. Having left England some fifty years ago, without once returning to his almost forgotten native land, and being acclimatized, the exile asks nothing better than to spend his declining years where he is. Speaking the vernacular like a native, he is more Malay than English.

An Undesirable Candidate

The natives, as in other colonies, see no reason why they should not oust the imported white boiler inspector. "It is," they plaintively state, "admitted that we are intelligent. Show us how a thing should be done and we are capable of doing it. We act as oilers wherever machinery is employed and some of us have even been promoted to the part of assistant engineer. Why then, in the name of the Great Spirit, withhold from us a coveted post which carries with it monthly pay, various emoluments, and a retiring pension?" Decidedly an eloquent statement of the case, and one which might appeal to those who have not met the Malay at close quarters. Unfortunately, he is—though intelligent—the essence of laziness and casualness, and, at times, quick tempered, drawing a murderous *kriss*, which he introduces, without compunction, between the shoulder blades of the *tuan bessar* (European) who has cause to reprimand him. The yellow man also is a confirmed taker of bribes, looking upon their acceptance as part and parcel of the business of life. Were the Malay to be entrusted with the inspecting of a boiler, he would—well, yield to bias. The government turns a deaf ear to his prayers.



Buffalo Carts are Used by the Inspector for Transport

The Chinese element (the Peninsula is full of "Chinks") also puts in a claim, based on much the same grounds, while the semi-Chinee—semi-Malay has aspirations in this direction. So, too, have the sons of European fathers and colored mothers, each passionately arguing his fitness for the coveted post. These applications are ruthlessly turned down, the powers-that-be deciding that boiler inspecting is best entrusted to the unadulterated white man. The disappointed candidates, airing their views in the "Utusan Malayu" ("Malay Herald") and other vernacular newspapers, declare that the government is composed of tyrants compared with whom Nero was an enlightened philanthropist. The editor supports them in a ferocious leader, and those who have snowed up the native press, resting on their literary oars, await developments. They still are waiting.

To satisfy the malcontents, a few appointments have been temporarily given to Malays and half-castes—and with disappointing results. None of these specially-appointed boiler inspectors have justified the trust reposed in them. Inherent laziness and other failings have proved their downfall.

Bullock Cart Transport

Except in the towns, there is little work for the boiler inspector. Several heated days may pass by without a "job of work" being assigned him. When, however, he is sent into the district, covering a long journey by pony, river boat, and perhaps by a jolting bullock cart over a road which is all ruts and holes, the much-tried man certainly has earned his day's pay and traveling allowances. If the boiler inspector is no horseman, the bullock cart may be the only alternative. Drawn by two cross-grained animals, who, should the humor seize them, calmly sit down till the driver's goad succeeds in making an impression on their extra-tough hides, the rate of progress is limited to rather less than three miles an hour. When no government "rest house" is handy, the boiler inspector must sleep in the bullock cart, the thatched roof of which keeps off the night dew. A mosquito net protects the sleeper against the pestiferous insects, and, should he awake in the night with a raging thirst, a huge water bottle packed in damped grass is at his disposal. The mosquito net is arranged so as to cover the space occupied by the bottle. Raise the extremity of the tucked-in net but a quarter of an inch, and in pop the buzzing tormentors—ready to goad the rash inmate into a state of frenzy. He thanks his lucky stars when fiery sunrise drives away these pests.

In default of a "rest house" the boiler inspector may find accommodation of a primitive nature in a wayside village. The headman, greatly impressed at seeing a white face, provides the *tuan bessar* with a primitive bed, across which a net work of fiber is stretched. A supper of freshly-caught fish (tasteless and abnormally bony), rice (cooked to perfection), and roasted bananas, is served, the villagers respectfully looking on while the grateful boiler inspector makes short work of the victuals. The next day the guest, after settling the score, expresses his sense of indebtedness, and politely hopes that all will ever be well with the village. "We ask nothing better," chorus the villagers, "than to be blessed with a good rice crop. Pray intercede on our behalf with the Great Spirit!" The intercession is promised, and the bullock cart once more creaks its weary and laborious way over the interminable ruts. A rough road,—none rougher.

The boiler inspector is not always so lucky as to light upon a friendly host, it sometimes happens that the Malay, craftily watching his opportunity, whips out the *kriss,* and, helping himself to the victim's note case and other possessions, deposits the corpse in the jungle. A tiger devours it; the driver of the bullock cart is informed that the white man, greatly daring, has sought the wild beast in its lair; and there is promotion in the ranks of boiler inspectors. Sometimes an inquiry brings the offenders to book; their guilt is proved right up to the hilt; they are hung as high as Haman.

In Singapore the boiler inspector may be kept busy. Steamers with doubtful boilers are ever coming and going, many of these craft being owned by Chinese firms, which, attaching no importance to human life, are not particular as to the state of the boilers. So ancient and decrepit are some of these boilers, with their thin, rusted plates, that a white fireman would refuse to sail with them. Fortunately for the owners, a "Chink" fireman is far too great a fatalist to be worried by trifles. "One must die," he argues. "Has not Buddha willed it? Dare a Buddhist go against the ruling of Buddha?" So the Chinaman is ready to face death by scalding.

The Traveling Boiler Inspector Stops at Such Places for Refreshment

The railway terminus also affords employment for the boiler inspector; and his duties include periodical visits to the ship repairing yards, as well as to various concerns where boilers are in use. At the end of a sweated day he is glad of a long cane-bottomed chair, in the shady veranda of his bungalow, a Manila cheroot and a *stringer* peg (iced whiskey and soda). The perspiring man has earned these luxuries.

New Boiler Law in Pennsylvania

Two laws pertaining to the collection of fees for services rendered by the Department of Labor and Industry, Commonwealth of Pennsylvania in the administration of the rules and regulations of the department covering boilers and elevators were passed at the last session of the legislature.

The *Boiler Law* provides for the inspection of boilers by representatives of insurance companies and by salaried employees of the Department of Labor and Industry. Owners and users of boilers will be required to forward to the Department of Labor and Industry a fee of one dollar before the annual certificate of operation for the boiler will be issued.

When boilers are inspected by representatives of the Department of Labor and Industry a fee of six dollars and fifty cents ($6.50) will be collected for each external and internal inspection made while the boiler is not under pressure, and two dollars and fifty cents ($2.50) for external inspection made when the boiler is under pressure.

Examination for Inspectors

Persons desiring to take examination for boiler inspector are required to pay a fee of ten dollars ($10.00) at the time of making application for examination. If the applicant is successful in passing the examination a certificate of competency and a commission card will be issued without further charge.

It is the plan of the Department to put this law into effect as soon as the necessary forms can be printed.

Methods of Applying Flues in Locomotive Boilers*

This report, which was read at the annual meeting of the Master Boiler Makers' Association held at Detroit, May 23 to 26, was compiled from the flue practice of the more important railroads of the country. It includes details of how flue ends should be prepared, the manner of preparing holes in the tube sheets, the type and size of copper ferrules to be used and the method of tightening flues in the sheets, as well as the standard tools for rolling, prossering and beading flues.

After checking up the methods of various railroads, it is believed that for a two inch diameter flue, flues should be swedged 1¾ inches diameter for a distance of seven-eighths of an inch straight, then tapered back to nothing for a distance of 3⅛ inches. This is far superior to a flue swedged 1⅞ inches diameter straight for one inch, with a taper of one-quarter to its original diameter, to provide increased water space, for it is a well recognized fact that the first few inches of the flue measured from the flue sheet, is the most efficient heating surface. This increased water space allows the steam bubbles to form and pass up between flues unrestricted. If it is not provided, the bubbles are

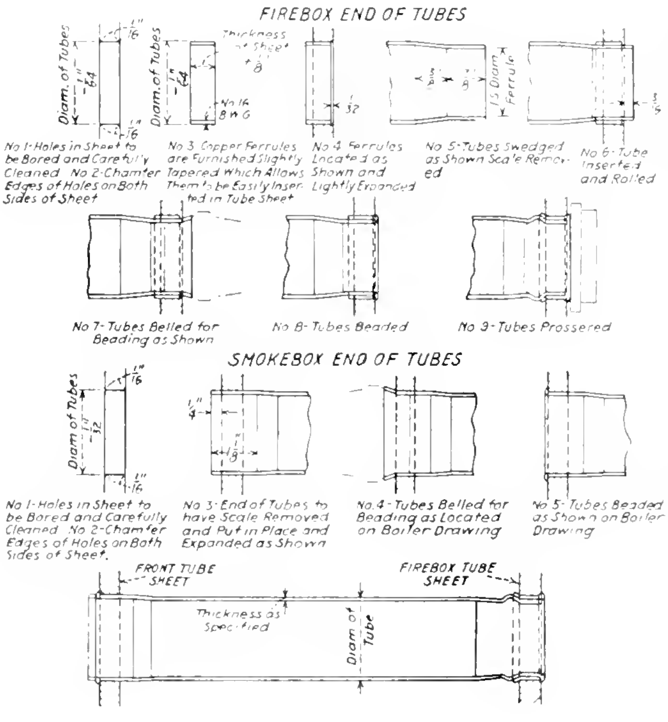


Fig. 1

trapped between the flues and drive the water away from the flue sheet. This causes the flue sheet and flue ends to overheat. This is one of the best known methods of shortening the life of flues. After being swedged flues should be annealed and care taken to see that all scale is removed from that part of the flue which is to enter the sheet, for it is a well known fact that we are unable to get tight flues with scale or any dirty substance between the copper ferrule and flue.

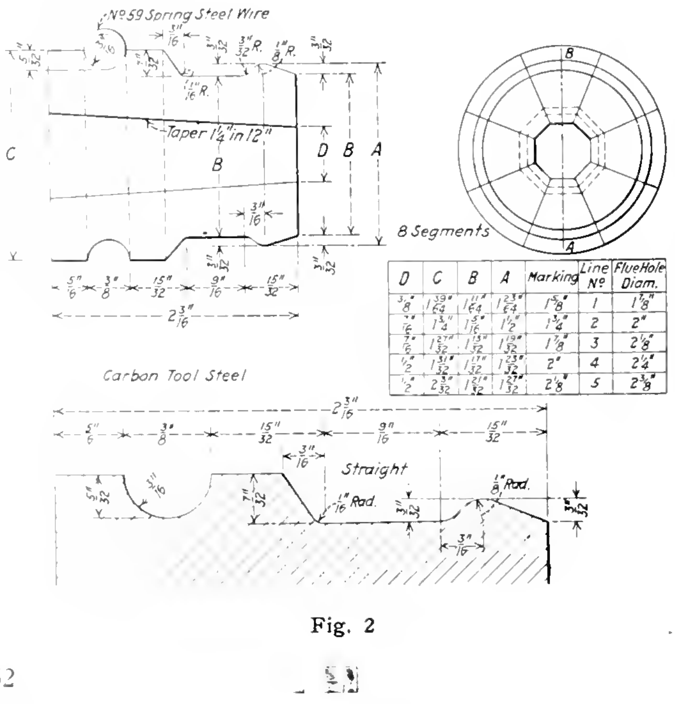
The swedging of superheater flues seems to be the general practice on all our railroads, the swedge being of the following dimensions: In 5½-inch outside diameter flues, 4½ inches outside diameter, 5⅛ inches straight, tapering to the 5½-inch diameter, three inches back; flues to be prepared as to the removal of scale the same as on smaller flues.

Preparation of Flues for Installation

The preparing of flues, both small and superheater for the front tube sheet, seems to lie between the practice of shimming the same with tin, or expanding to fit the hole. Expanding should be done before the flue leaves the flue department, for good results can be obtained when heated properly, for there are many simple ways that are not harmful to flues. In shimming flue with tin, there is a possible chance that when the boiler maker applies the shim he will not get it through the sheet, so that it may blow out, causing a failure besides possible damage.

Drilling flue holes in the back flue sheet will have to be governed by the diameter of the swedge and copper ferrule used. The committee recommends that all flue holes in back flue sheet have inside and outside edges slightly rounded, to remove the sharp edges, the radius to be about 1/16 of an inch. Flue holes in old back flue sheet should be examined for sharp edges, rust and scale and the same removed. Holes 1/32 inch or more out of round, should be reamed. In this you will readily see the advantages of a 1¾-inch diameter swedge over a larger size. The smaller flue hole will give increased bridge strength between the flues, and at this time, when it seems to be the general practice on most of the railroads to electric weld the beads of flues to the back flue sheet, a greater space is required between the flue beads. If not provided, the electric welds will over-lap each other, which is not a good practice.

Drilling holes in the front flue sheet seems to be a general practice as to the diameter on all our railroads. The committee recommends that all holes drilled for flues smaller than superheater be 1/16 of an inch larger than the outside diameter of flues, and for superheater flues three thirty-seconds larger than the outside diameter of flues. Holes



D	C	B	A	Marking	Line No	Flue Hole Diam.
3/8"	1 39/64"	1 11/64"	1 23/64"	1⅝"	1	1⅞"
7/16"	1¾"	1 5/16"	1½"	1¾"	2	2"
7/16"	1 27/32"	1 13/32"	1 19/32"	1⅞"	3	2⅛"
½"	1 31/32"	1 17/32"	1 23/32"	2"	4	2¼"
½"	2 3/32"	1 21/32"	1 27/32"	2⅛"	5	2⅜"

Fig. 2

*Report prepared by a committee consisting of A. F. Stiglmeier, chairman; E. C. Umlauf and James F. Walsh.

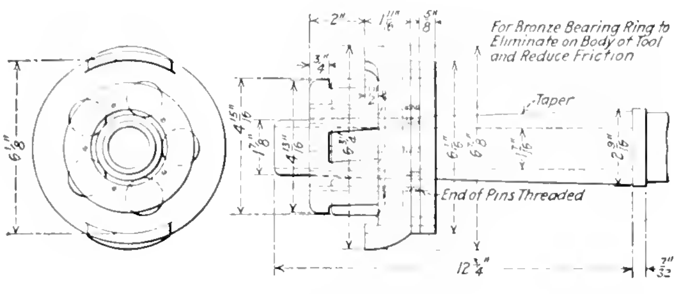


Fig. 3

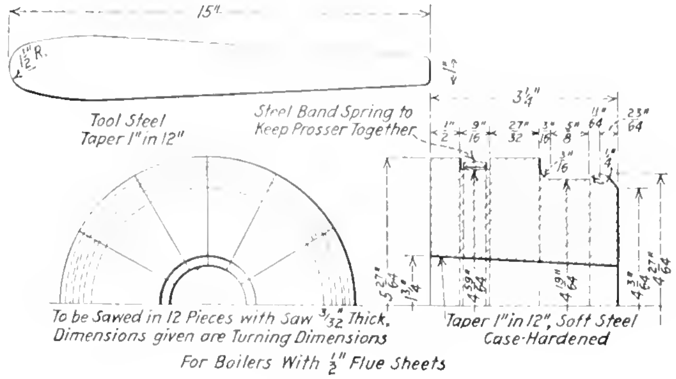


Fig. 5

should be prepared the same as for back flue sheet, by removing the sharp edges from the inside and outside of sheet.

Copper Ferrules Used

The committee recommends a copper ferrule 1/16-inch. (0.065 thick), by 1/8 inch over the thickness of flue sheet for the width for both small and superheater flues, ferrules to be of soft, seamless copper, annealed. While many railroads are using a copper ferrule of the same width as the thickness of sheet, the committee believes this to be too narrow, as the function of a copper liner is to provide a yielding medium between the flue and the sheet, so that the flue will take a light, permanent set when expanded. It is just as important that the soft medium be applied between the bead formed by the sectional expanders on the inner edge of flue hole, as between the flue and flue hole. The committee recommends that sectional expanders be used to apply copper ferrules and great care be taken that the ferrule is set 1/32 inch inside of the edge of hole on the fire side of sheet. This is of great importance because if it is left even with the fire side of the sheet there is a possible chance that when the flue is expanded the ferrule will project outside the fire side of the sheet, and after being beaded it will work itself outside of the edge of the bead. This we all know will not do on flues that are to have beads electric welded to the back flue sheet, for it is a well-known fact that copper will not mix with the electrodes used in welding.

The committee further recommends that flues smaller than superheater project through back flue sheets 3/16 inch for beading. When a small flue is to be beaded at the front flue sheet 3/16 inch is to project through the sheet; when it is not to be beaded the minimum is to be 3/16 inch and the maximum 1/2 inch. Superheater tubes are to project through the back flue sheet one-quarter of an inch, and one-quarter of an inch to be used on front flue sheet when flues are to be beaded. When superheater flues are not to be beaded at the front end, the minimum and maximum length for flue to project through flue sheet is to be the same as small flues.

Tightening Flues in Sheet

Tightening of flues in the back flue sheet seems to be quite a delicate subject, for checking up the methods of the various railroads shows a leaning toward the use of the sectional expanders to tighten flues. The committee does not care to recommend it, but does recommend that roller expanders be used in the firebox end as well as the front end to tighten flues. The chairman has made a test of both and finds that the sectional expander does the flue harm, as sectional expanders have to be turned two or three times. The first time the pin is driven into them a small space between each section is not expanded. This is where the harm occurs, as flues are checked at this point, but it cannot be noticed. After they are electric welded the heat will open up the checks and develop leaks, after running a short time. These conditions also exist in flues that are not electric welded at the bead after being in service. Such conditions will not exist on flues that have been tightened in the sheet with roller expanders, which give equality of expansion. The committee recommends that after flues are tightening in the

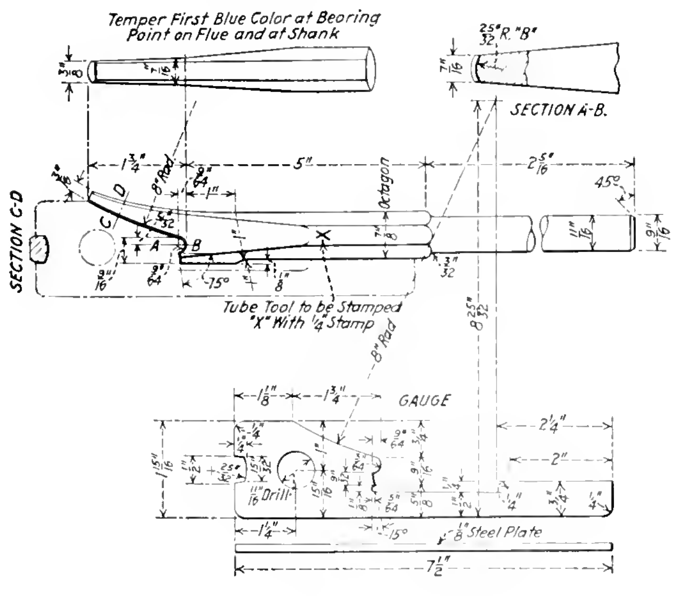


Fig. 4

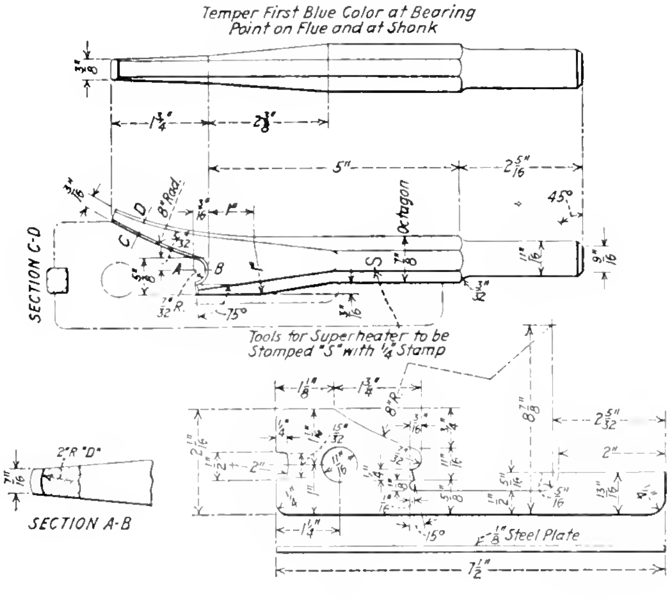


Fig. 6

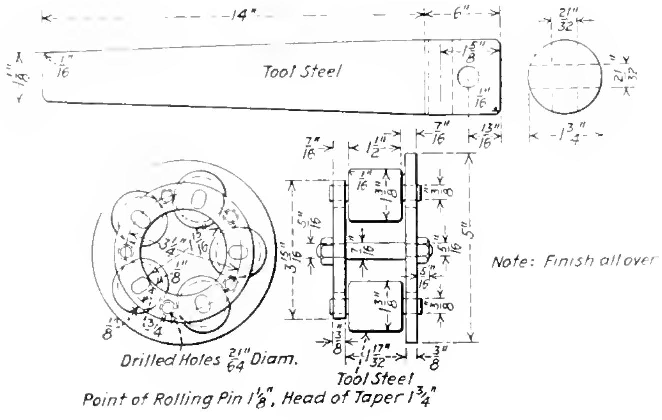


Fig. 7

back flue sheet, sectional expanders be used to expand them inside of the sheet. They are then to be rolled in the front end. Flues should not be beaded at the front or back end until after the boiler is tested. Investigation of different cases of leaking flues has shown that by the other method of testing leaking flues may be covered up. If a flue tested before being beaded shows no leak it will not developed a leak after being in service a short while.

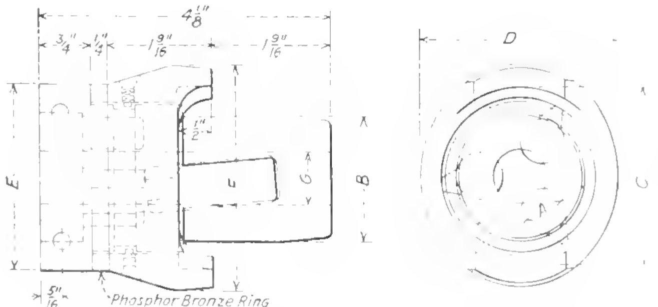
Figs. 1 to 8 inclusive show sketches of standard tools for rolling, prossering and beading tools, as well as various operations incident to flue installation.

The committee also recommends that a flue roller should never, under any circumstances, be used in a flue after it has been expanded with a sectional expander. It will stretch the metal and break the joint made by the sectional expander and beading tool.

Applying Flues in Stationary Boilers

As to the application of flues to stationary boilers, the chairman corresponded with various boiler manufacturers and among replies received were the following:

"In applying flues to water leg type of watertube boiler, using four inch tube expanded into one-half inch plate in each boiler leg, we first roll the tube in position with three parallel rolls; then take out one of the rolls and put in a roll designed to bell the end of the tube which extends into the water leg. The tube end is thus belled or flared to comply with the A.S.M.E. Boiler Code. We are now experimenting with another type of expander body and have had good results, so far. This body has three rolls, two of which are slightly tapered so that the surface of the tube as rolled will be parallel to the axis of the tube—in other words, the outside edge of the rolls, where it comes in contact with the tube, is exactly at right angles to the tube sheet. The other roll in this new type of expander is designed to bell or flare the end of the tubes, thus the rolling and flaring is done at the same time."



G	F	E	D	C	B	A	SIZE	USED ON	LINE NO
[illegible]	2 3/4	[illegible]	[illegible]	[illegible]	1 3/8"	1/2"	1 5/8"	2" Tubes Rear New Work	1
[illegible]	2 7/8"	2 5/8"	2 1/2"	2 1/4	1 1/2	3/16"	1 3/4	2" Tubes Rear Repair	2
[illegible]	3"	2 7/16	2 5/8"	2 3/8	1 39/64"	19/32"	1 7/8"	2" Tubes Front New Work 2 1/4" Tubes Rear New Work	3
25/32	3 1/8"	2 9/16"	2 3/4"	2 1/2"	1 23/32"	5/8"	2"	2" Tubes Front Repair 2 1/4" Tubes Rear Repair	4
25/32	3 1/4"	2 11/16"	2 7/8"	2 5/8"	1 13/16"	11/16"	2 1/8"	2 1/4" Tubes Front New Work	5
25/32	3 3/8	2 [illegible]/16	3"	2 3/4"	1 15/16	3/4"	2 1/4"	2 1/4" Tubes Front Repairs	6

Fig. 8

Tools for Expanding and Working Flues in Stationary Boilers

"In answer to your inquiry we are attaching herewith two prints showing general type of tools used in expanding the ends of tubes in Heine boilers. The sheet which contains a picture of a Heine boiler also shows the general type of tool which is used by power plants for the renewal of individual tubes when it becomes necessary. The other print shows the general type of expander used in the shop. You will note that this latter tool is more elaborate in that it has a collar which acts as a guide for the mandrel as well as to take the thrust caused by the rollers when the mandrel is driven in place. In Heine boilers it is not required that the ends of the tubes be beaded, but it is necessary to flare them. The American Society of Mechanical Engineers Boiler Code, under which we construct most of our boilers, calls for the tube ends to be flared to at least one-eighth inch over the diameter of the tube hole. Ordinary roller expanders have a tendency to slightly flare the projecting ends when the rolling is done, but a slight additional flare is provided by driving a conical piece into the tube end holes, spreading it the required amount. One or two licks of a comparatively heavy hammer will do this flaring without loosening the tube where it has been rolled."

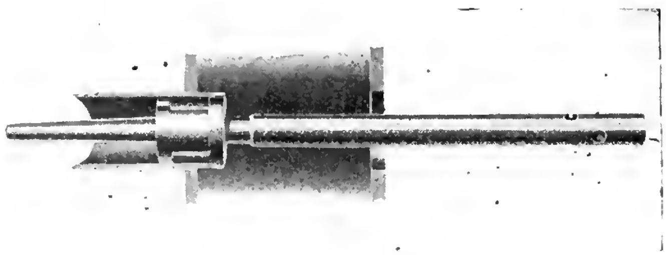


Fig. 9

Tools for stationary boiler tubes are shown in Figs. 9 and 10.

"The great majority of boilers we manufacture are of the fire tube type for stationary purposes. It has always been our custom to use a prosser expander for putting tubes in fire tube boilers; after the tubes have been expanded by means of the prosser we bead the tube against the sheet. We allow 1/64 inch clearance between tube and sheet. Some times we are requested to provide the rear tube sheet with copper ferrules. Where copper ferrules are used we follow the same procedure and use the prosser expander. Some manufacturers simply roll the tubes in the sheet, but we do not consider it good practice as we feel that in a fire tube type of boiler the tube is acting more or less as a stay and by expanding the tube by means of a prosser expander that portion of the tube expanded inside the tube plate acts more or less as a lock nut would act on a stay rod. In building boilers of the watertube type we, of course, roll the tube and after rolling flare the end of the tube."

"1. Tubes for stationary watertube, and flues for fire tube steam boilers shall conform as to specifications of manufacture and thickness to the following instructions and shall be requisitioned in accordance therewith.

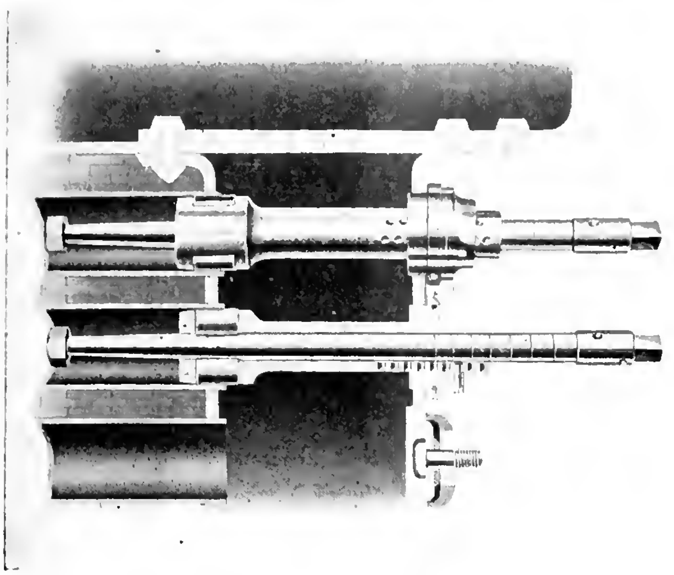


Fig. 10

"2. Tubes for stationary watertube steam boilers shall conform to Department of Tests' Specification, and thickness shall be as follows:

(a) Up to but not exceeding 165 pounds per square inch for tubes of Diameter less than 3 inches. No. 12, B. W. G.—0.109 inch thick.
Diameter 3 inches or over, but less than 4 inches No. 11, B. W. G.—0.120 inch thick.
Diameter 4 inches or over, but less than 5 inches No. 10, B. W. G.—0.134 inch thick.

(b) Over 165 pounds per square inch but not exceeding 235 pounds per square inch for tubes of Diameter less than 3 inches No. 11, B. W. G.—0.120 inch thick.
Diameter 3 inches or over, but less than 4 inches No. 10, B. W. G.—0.134 inch thick.
Diameter 4 inches or over, but less than 5 inches No. 9, B. W. G.—0.148 inch thick.

NOTE—For (a) and (b) above next heavier gage than that indicated for each respective pressure may be used for those tubes which are directly over the fire—such as the first and second rows of tubes in B. & W. boilers, etc.

"3. Flues for stationary fire tube steam boilers shall conform to Department of Tests' Specification and thickness shall be as follows:

(a) Up to 175 pounds per square inch for tubes of Diameter less than 2½ inches No. 13, B. W. G.—0.095 inch thick.
Diameter 2½ inches or over, but less than 3¼ inches No. 12, B. W. G.—0.109 inch thick.
Diameter 3¼ inches or over, but less than 4 inches No. 11, B. W. G.—0.120 inch thick.
Diameter 4 inches or over, but less than 5 inches No. 10, B. W. G.—0.134 inch thick.

(b) Over 175 pounds per square inch but not exceeding 250 pounds per square inch for tubes of Diameter less than 2½ inches No. 12, B. W. G.—0.109 inch thick.
Diameter 2½ inches or over, but less than 3¼ inches No. 11, B. W. G.—0.120 inch thick.
Diameter 3¼ inches or over, but less than 4 inches No. 10, B. W. G.—0.134 inch thick.
Diameter 4 inches or over, but less than 5 inches No. 9, B. W. G.—0.145 inch thick.

Responsibility for Boiler Equipment

A RECENT letter to members of the American Boiler Manufacturers' Association, sent out by the secretary, H. N. Covell, calls for an expression of opinion on the subject of the difficulties that the manufacturer sometimes has with back charges for boiler fittings and equipment. The letter is given below for the information of the industry. The secretary will be glad to hear from members and forward a report of the replies to those interested.

"There is a source of annoyance and expense to which we have been subjected in recent months to such an extent that we are compelled to seek some remedy, and are addressing you in the hope that you may be able to present our case to the members of the A. B. M. A. and obtain an expression as to whether they are having similar troubles, and if so, what their general attitude is.

We refer to back charges of the class outlined below made by the customer:

1. Reported shortages of fittings or small castings, which are later found in some corner or under some rubbish, usually after the replaced part has been rushed forward by prepaid express.
2. Broken castings and other damaged items which are accepted from the railroad company by the customer without proper notation of such damage having been made on the bill of lading.
3. Damage caused by careless unloading and by careless handling on the part of truckmen and riggers.
4. It has been our policy to consider the customer first and to do everything to get his equipment operating, and then discuss the question of responsibility.

Recently however, so many cases have come up where the blame could not by any stretch of imagination be laid at our door, and still the customer has flatly refused to accept any responsibility.

We cannot feel that this is a condition peculiar to ourselves and if it is not, we would certainly appreciate an expression from some of our fellow members as to their method of handling similar situations.

If this condition is as prevalent in other fields as in our own, it would seem advisable for our members to adopt a general policy for their own protection and such a policy if adopted by even the majority of our members would certainly be of tremendous advantage.

Of course, we appreciate it is difficult to draw a hard and fast line, but if we had a rule covering the majority of such cases it would prove a real help.

We know one large concern which takes the stand that when goods are accepted and receipted for by the railroad company, their responsibility ceases; when the packers' list is properly checked, they also refuse to make good any reported shortage; they positively will not ship a replace part without definite advice that the customer intends to pay for such replacement. In other words, they take the stand that they (the manufacturers) are right which is just the opposite to our policy.

However, we are beginning to question whether our policy is proper under present conditions. We all know that boilers are being sold today on a very close margin, and there is simply not enough room above actual cost to take care of unjust back charges.

Address communications to H. N. Covell, secretary, American Boiler Manufacturers' Association, 191 Dikeman Street, Brooklyn, N. Y.

Horsepower of a Horse to Be Determined

THE actual horsepower of a horse will be determined at the Iowa State Fair this year where scientific tests will be made.

A specially constructed wagon has been designed for the tests by the engineering department of the Iowa State College. By means of gears and a hydraulic pump driven from the wheels, it will be possible to put on any predetermined load and maintain uniform load resistance from the test wagon, whether it travels on a level or up or down hill. The teams probably will be required to pull a six-horsepower load to enter, the load to be increased by two horsepower on each successive trial until the maximum is reached.

Horsepower has been a standard of power measurement for years, but little research work in the hauling power of horses and mules has been carried on scientifically because of the difficulty in providing a uniform tractive resistance.—*Power.*

Results of a Recent Investigation of the Strength of Welded Pressure Vessels*

AN extensive publication has been prepared which may be divided into three parts, namely: A report of tests carried out by the Bureau of Standards; an analysis of test data given in this report and comments on the various features considered; and finally, recommendations made by the Pressure Vessel Committee of the American Bureau of Welding for the consideration of the Boiler Code Committee of The American Society of Mechanical Engineers in a revision of the Code for Unfired Pressure Vessels.

As regards the report of the Bureau of Standards it deals with an investigation of the strength of welded pressure vessels. As it is expected that it will be published by the Bureau in the usual manner, at which time it will be available at a very low cost to all those interested in the subject, only the conclusions arrived at are reported here. These are:

1. The double V-weld is much superior to the single V-weld.
2. The pipe shells tested were less uniform and averaged lower in strength than double V-welded plate shells.
3. The butt-welded heads were stronger than the inserted heads.
4. A hammer test cannot be relied upon to show more than a very few exceptionally defective welds.
5. The hammer test, as applied, apparently did not weaken the tanks.
6. Hydrostatic pressure 1½ times the working pressure showed only a small number of imperfect welds, even when the hammer was used.
7. Hydrostatic pressure sufficient to stress the shell to the yield point will show a large proportion of imperfect welds.
8. Hydrostatic pressure sufficient to produce a permanent set in the shell, enlarging the circumference ½ percent, apparently does not weaken the tank.
9. Flanges for inspection plugs can be welded in the heads of a tank without weakening it.

The comments on the report of the Bureau of Standards fall into several sections. In those dealing with construction it is pointed out among other things that there is one principle which it is felt should be carried out in all welded steel structures of importance, which is that the included V-angle should not be less than 90 degrees.

The shells in these tanks were crimped over the heads, a construction that is thought by many to give added strength. There is some doubt, however, as to its effectiveness, though this must increase as the diameter of the tank decreases, the thickness of the shell and the amount of crimping being the same. The drawing of these tanks submitted by their maker shows such an amount of crimping as to make the V-angle so small that it is quite impossible to make the weld as indicated. The photograph of the actual sections shows this to be true, and it seems clear that, considering the small amount of weld metal actually holding, and the fact that there is bad bending action in the weld, the very high factor of safety is all that saves the construction from failure, and so the design cannot be commended. It is believed that other designs, more efficient, and probably just as cheap, are available, and that they should be used in the interests of safety. Of course there can be no objection to the use of pipe for the shell with a proper factor of safety, and with flanged heads butt-welded to the shell the construction would be beyond criticism.

In one of the tanks tested, in fact, the strongest of the lot, it was found that there was a severe strain on the head weld caused by its rigidity which kept it from bending while the material on both sides of it could distort. In another instance one of the head welds cracked under the hammer test.

The maker reports that during the 50-lb. hydrostatic shop test for tightness there were found two damp spots, one in each head seam, which were rewelded, and after retest were found tight. It is not possible now to identify these spots, but the crack may be at one of them.

This rewelding might account for a local stress, which, added to the test stress, might be of sufficient amount to cause local rupture. It is a very good illustration of what may occur if enough care be not taken in making repairs.

There are three points to note in this connection:

1. The static test at 1½ times the working pressure did not detect the defect.
2. The defect was found by the hammer at a lower pressure than 1½ times the working pressure.
3. The crack was evidently caused by local internal stresses because (*a*) it occurred at low pressure and (*b*) it was local.

So far as this case is concerned, it seems clear that something more than a static test is needed, and that a shock of moderate amount while the tank is under moderate pressure will show up defects not revealed by a static pressure of the same or somewhat greater amount.

It is probably a good thing that this tank failed as it did, as it shows that the Code provision for a reweld and retest is safe practice if the work is properly done. It is also evident that local stresses can exist in otherwise properly welded tanks, and that they have no effect on the strength of the rest of the welds.

Design of Tanks

It is claimed that the best method for applying heads is by butt-welding a flanged head to the shell, and where a head convex to the pressure is used the method in the Code should be followed.

As regards the question of what fiber stress should be used in designing unfired pressure vessels, the conclusion is reached that it seems quite fair and safe to use 50,000 pounds as the basis for design. With a factor of safety of 5, and a weld value of 80 percent, this would mean a design fiber stress at the working pressure of 8,000 pounds, based on the nominal plate thickness. In view of the high efficiency of the double V-weld, 97 percent or 9,700 pounds fiber stress, using the above basis, this does not seem to the committee excessive, unfair, or in any degree dangerous, and they therefore recommend its adoption. It would apply also to the special tanks, only 4 of the 23 having less than 50,000 pounds tensile strength.

For wrought-iron pipe used for pressure vessels a maximum working fiber stress of 4,000 pounds is recommended, although it is pointed out that steel pipe is just as easy to obtain and makes the construction safer.

The committee considers it inconsistent to allow 150 pounds for air tanks and 250 pounds for ammonia tanks. It believes that it is entirely safe to put all liquids or gases on the same basis as far as welding is concerned.

The committee also objects to the requirement in the Code to the effect that heads convex to the pressure shall have a skirt not less than 3 inches long. This is impractical for smaller-sized heads and the committee recommends certain relations between the length of the skirt and the diameter of the head. Also the committee believes that the constricting

*From *Mechanical Engineering*

or crimping of the end of the shell is unnecessary, although not objectionable. The committee also recommends a certain form of convex head. The necessity for this is due to the fact that as heads convex to the pressure are much thicker than the shell, the welder is at some disadvantage unless the head is reduced in thickness. There are a number of other recommendations which cannot be reported here on account of lack of space.

Hydrostatic Hammer Test

A search was made by one of the committee, but only a few references have been found, and they are merely references to the fact that it is used.

The American Society for Testing Materials provides in its specification for cast-iron pipe as follows:

Section 14. The straight pipes shall be subjected to a proof by hydrostatic pressure, and if required by the engineer they shall also be subjected to a hammer test under this pressure. [No details of how the test is to be applied are given.]

The pressure to which the different sizes and classes of pipes shall be subjected are as follows:

Class	Working Pressure[1]	Test Pressure: 20 in Diam. and Larger	Test Pressure: Less Than 20 in.	Fiber Stress at Test Pressure	Fiber Stress at Test Pressure[2]
A	43 lb	150 lb.	300 lb.	4 in., 1,420 lb. 18 in., 4,200 lb.	20 in., 2,230 lb. 60 in., 3,230 lb.
B	86 lb.	200 lb.	300 lb.		
C	130 lb	250 lb.	300 lb.		
D	173 lb.	300 lb.	300 lb.	4 in., 1,150 lb. 18 in., 2,700 lb.	20 in., 2,900 lb. 60 in., 3,780 lb.

[1]Added to table.
[2]Calculated from data in specifications.

It will be seen that the ratio of test pressure to working pressure varies widely—from about 7.0 to 1.7—and that the fiber stresses in the table are likewise irregular and variable. The committee is not in a position to criticize, and simply points out the variations as indicative of either unusual conditions or of lack of standardization, probably the latter.

The data and wording of the American Water Works Association specifications are identical with those of the American Society for Testing Materials.

Statements are given of methods of hammer testing cast-iron and steel pipe. From both it will be seen that the hammer used is not heavy, and, from a study of the tables of test pressures, that the fiber stresses used are not as high as in the Bureau of Standards' tests. The test pressures in the proposed revision of the A.S.M.E. Rules for Piping and Fittings are the same as those of the American Society for Testing Materials, and no hammer test is specified in either case.

On the other hand, there are data in favor of this test. One of the members of the Boiler Code Committee, who is a strong advocate of the Code test, states that in his experience it has been of much value in detecting leaks and other imperfections.

One of the members of the present committee, who has used the hammer test for several years, states that by employing it some leaks have been found that were not shown up by the pressure alone, and he would not want to omit its use.

It has been the experience of one job welding shop, in the case of many hundreds of cast-iron vessels, ranging in size from small auto cylinders to very large heating-boiler sections, that, with a city water pressure of from 40 to 60 pounds, an ordinary machinist's hammer, used in proportion to the weight of the vessel, will invariably detect a strain due to uneven shrinkage, and that if no effect is produced by the hammering, there is also invariably successful service. It has also been their practice for over five years, in cases where the working pressure is known, to use the Code test on all welded cast-iron pressure vessels, such as steam-jacketed kettles, and they state that they would not feel safe in letting them leave the shop without being so tested, and that no vessel of this type passing this test has ever failed in service.

It is their belief that the test is specially adapted to detect strains, which are serious in cast-iron welds, and that it will not, from their experience, detect an imperfect cast-iron weld unless there is a strain in it, because the factor of safety in the vessels, referred to is made very high because of foundry conditions, so that even an imperfect weld will be plenty strong enough.

The statement usually made as far as the committee knows, is that the Code test should detect a bad weld. At once the question may be asked, What is a bad weld? The committee knows of no attempt to evaluate or define it. There are evidently various degrees of badness in welds, as in anything else, but in the tests no "bad" weld was detected by the Code test except one (Tank X15). The other one found by it was a good weld (Tank K4), containing a local strain, which was repaired and the tank on retest broke at 50,500 pounds fiber stress. It is quite probable that X15 had a strain in the weld, due to the thin welds having to stand all the shrinkage stress.

The committee has inquired of its members and others as to their idea of a bad weld, which would be discovered by the Code test, and has found that none of those questioned had any definite opinion on the matter.

The Code has no specifications for the pipe which was used for nine of the regular tanks tested. The committee feels that wrought-iron pipe being naturally weak longitudinally in the tank or transversely in the skelp, is not a suitable material for pressure vessels unless the factor of safety is very high, and that lap-welded steel pipe could be used instead without any hardship.

The subject of high- or low-tensile-strength plate for welding is discussed in some detail. As regards the yield point, it is believed to be perfectly safe to allow a high yield point, especially since the material is annealed by the welding for quite some distance from the weld. This annealing increases the elongation, allowing the steel to absorb the welding strains in spite of higher tensile strength than the Code allows. From the foregoing it is safe to provide that material 1/4 in. thick or less shall have the following physical properties:

Tensile strength (T. S.), pounds per square inch	60,000 max.
Yield point, pounds per square inch	0.5 T. S. min.
Elongation, percent in 8 in.	1,500,000/T. S.

provided that the elongation be measured on a gage length of 24 times the thickness and that the Code chemical analysis be complied with, and the committee so recommends. The committee believes that the use of a definite minimum for the yield point is not as good as the limit used in the Boiler Code in which the yield point is equal to 0.5 T.S. min., because the former excludes Armco iron, a very good material, while the latter admits it. Whatever form of specification is used, Armco iron should be allowed. Further, the committee believes that if its recommendation as to hydrostatic test at three times the working pressure be adopted, the yield point minimum of 24,000 pounds is too low, as it is just three times the fiber stress, 8,000 pounds, of which the committee is in favor.

Chemical Requirements of Plate

The committee recommends the following as a specification that will fit all cases:

	Percent Max.		Percent Max.
Carbon	0.15	Phosphorus	0.04
Manganese	0.30 to 0.60	Sulphur	0.05

It is believed that there should be a low limit on the manganese, to insure good steel, and 0.30 per cent is recommended. This would exclude Armco iron, which is entirely suitable for pressure vessels, provided its low tensile strength (about 45,000 lb.) is allowed for, and its use should be permitted by some such wording as, "The use of ingot iron is permitted provided a fiber stress of 7,200 lb. per sq. in. at the working pressure is not exceeded." (*Journal of the American Welding Society*, vol. 2, no. 5, May, 1923, pp. 11 to 162, 120 figs., *ep.A*).

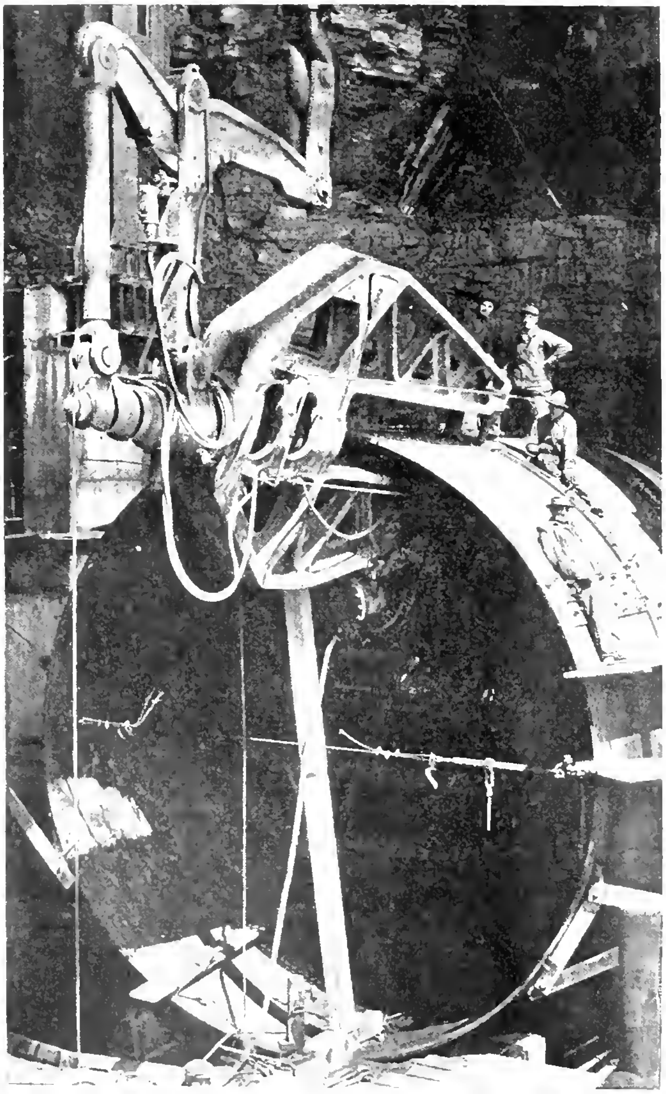
Record of Riveting Made on Heavy Pipe Work

Schedule of Forty-five Rivets in Thirty-five Minutes Maintained by Largest Portable Riveter in Use

A RECORD of 450 rivets in a working day of 8 hours has been the average performance of the bull riveter in use on the penstock work at the Niagara Falls Power Company tunnels at Niagara Falls, N. Y. On a regular run 45 rivets in 35 minutes was the schedule. The riveter, the largest portable machine in use, was built by the Hanna Engineering Co., Chicago.

Work on the second penstock has just been completed so far as the services of the riveter are concerned, and the third is not yet ready for riveting. The labor saving accomplished is computed at 66 per cent. The average work of a crew of seven men hand-riveting is 150 rivets in an 8-hour day. The labor-saving feature is enhanced, it is held, through the fact that with hand-driven rivets a percentage must be allowed for cutting out loosely driven rivets—a condition not found in the machine-driven work.

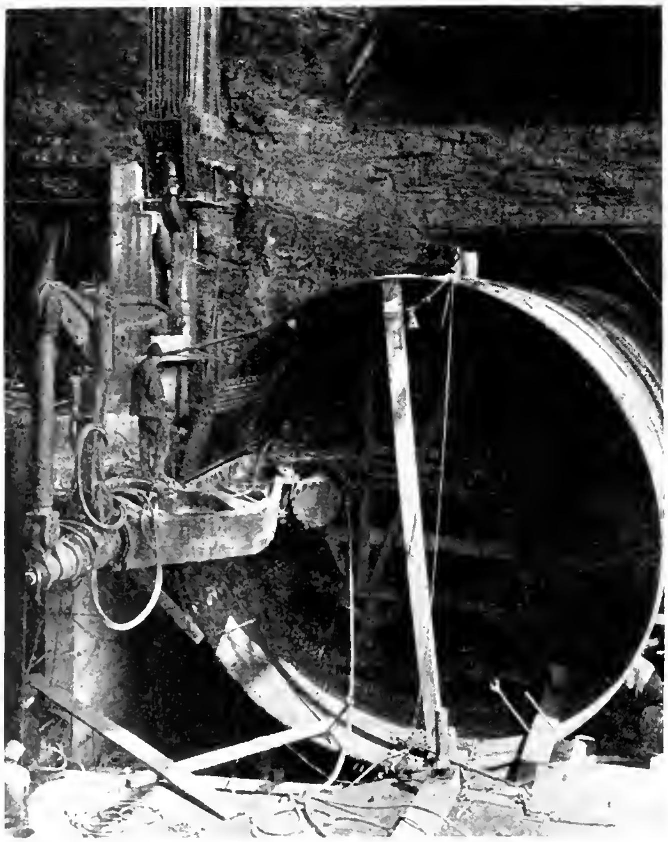
The rivets used on the penstocks are 1 3/8 and 1 1/2 inches in size. The plates are 1 3/8 and 1 9/16 inches in thickness, and were rolled at Homestead. The jaws of the riveter compress the plates under pressure of 150 pounds.



Riveter at Work on Penstock

Capacity of Machine

Each of the three penstocks is 21 feet in diameter for the supply of 70,000 horsepower turbines. The Hanna machine weighs 20 tons, and is slung from an overhead crane. It is balanced so that the operators can swing it in any position desired with but little effort. Air operated worms raise, lower or turn it.



The Riveter is Readily Controlled in Any Position

The work on the penstocks is done in the open, and as each ring is completed the tube is rolled into place on rails.

New Record in Repairing Locomotives

THE railroads of the United States from July 15 to August 1 repaired and turned out of their shops the largest number of locomotives for any semi-monthly period in their history.

Of the total number on August 1, 10,370 or 16.2 percent of the number on line were in need of heavy repair, a decrease of 414 since July 15. There were also on August 1 this year, 1,185 or 1.9 percent in need of light repair, an increase, however, of 114 over the number in need of such repair on July 15.

Estimate Being Asked for Scotch Boiler for Government Dredge

A NOTICE has been sent out from the U. S. Engineer Office at Montgomery, Ala., that proposals will be received until 11 A. M., October 1, for furnishing one steam boiler, with fixtures, stacks, etc., for U. S. dredge *Upatoi*, at Columbus, Ga.

Detailed Specifications of Boiler

Work to be done: The work to be done under these specifications is to furnish and deliver at Columbus, Ga., one Scotch Marine water-back boiler with equipment as listed below:

The following specifications are intended to describe in a general way the type and size of the boiler only. Bidder shall make all necessary computations for the thickness of plate, riveting, staying, etc., to obtain the working pressure stipulated.

General description. The boilers shall be built to comply with the General Rules and Regulations prescribed by the Board of Supervising Inspectors, Steamboat-Inspection Service (rivers), latest edition, in regard to design, construction, material, and workmanship for a working pressure of 200 pounds per square inch.

Cuts and description. Bidders shall submit cuts, blue prints, and a full description, with dimensions and weights, of the boilers they propose to furnish.

Tracings. As soon as practicable after receiving notice of award of contract, the contractor shall prepare and submit to the contracting officer for approval, two sets of detail tracings showing plan, cross section, and front and rear elevations of the boiler, with fittings attached. These sets of drawings shall become the property of the United States.

Boiler. One Scotch Marine Water-back boiler designed for a working pressure of 200 pounds per square inch. The shells shall be made of open-hearth steel having a tensile strength of 60,000 pounds per square inch; boiler to have not less than 1,200 square feet of effective heating surface and not less than 37 square feet of grate area. Furnace shall be of the Morrison suspension type and removable without removing front or back flue sheets. Tubes to be of genuine knobbled charcoal iron one gage heavier than standard. Boiler to be fitted with cylindrical steam drum of proper size with 5-inch main steam connection on side of drum facing toward end of boiler opposite the firebox. Boiler to be fitted with three 3-inch auxiliary steam connections along top of boiler spaced along center line. Suitable connections to be provided for 2 feed water lines, gage cocks, water columns, safety valve and blow off valve, etc. Manholes and handholds of proper sizes shall be fitted in head of boiler, steam drum, top and bottom of shell, and provided with cast steel covers and yokes, and with necessary gaskets and bolts.

Feed water connections. Two feed water connections shall be placed in front head of boiler at sides above the top row of tubes and same shall be provided with brass bushings and internal feed pipes extending from the front end of the boiler to within about 3 feet of the rear tube sheet, thence downward near side of shell for discharge near bottom of boiler.

Supports. There shall be furnished with boiler for supports three cast iron saddles of proper design, distance from deck plate to bottom of boiler to be 9 inches at center line.

Limiting dimensions. Length of boiler shell shall not exceed 18 feet; height from top of steam dome to bottom of saddle not more than 11 feet.

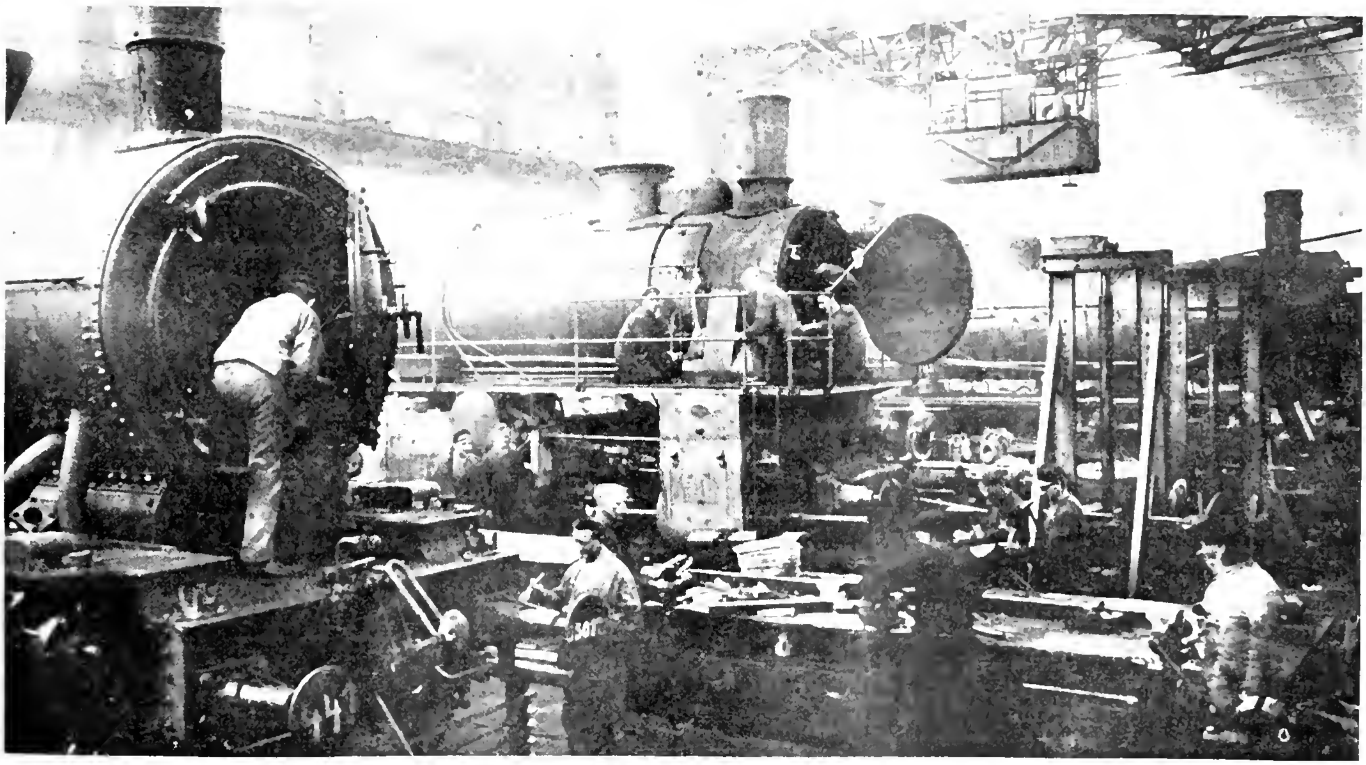
Fittings. Boiler shall be furnished with the following fittings:

Boiler front with liners and doors suitable for use with shaker grates as specified.

Steel breeching and uptake, height of smokestack connection (top of breeching), to be not more than 11 feet from deck.

One brass rim steam gage—12-inch diameter.

One safety water column with high and low water alarm,



Keystone View Company

A View of the Interior of the Famous Krupp Locomotive Works at Essen, Germany, in the Ruhr District

fitted with extra heavy bronze mountings for glass water gage of an approved type.

Three try cocks.

One stop valve for main steam connection.

One combination stop and check valve for main feed connection.

The combination stop and check valve for auxiliary feed connection.

One bottom blow-off valve of an approved type.

Bridge wall of an approved type.

One complete set of shaking and dumping grates of an approved type for burning bituminous coal.

One marine spring safety valve.

STACKS AND BREECHING

Stack. There shall be furnished with the boiler one stack of suitable diameter, 36 feet in length built of 14-gage steel and furnished in two sections, the upper section hinged 10 feet above the breeching with stack hinge of approved design. Four angle lugs and stack band for attaching guy wires shall be riveted on stack near the top of each section. An outside casing of 16-gage sheet, 3 feet long and 16 inches larger in diameter than the stack shall be furnished. Top of this casing will be supplied with a storm hood made in 2 sections, to bolt tight around stack and extend beyond outer casing. Four angle iron supports of proper size shall be bolted to the outer casing at a point one foot from bottom end to suspend it in roof of boiler room. Stack and casing shall be given 2 coats of black heat-resisting paint.

Inspection. The boilers will be subject to inspection by local inspectors of the United States Steamboat-Inspection Service and also by the contracting officer or his authorized representative. The contractor shall give these inspectors access to all parts of the work and such facilities as may be required for the proper performance of their duties.

Tests. Before shipment the boilers shall be hydrostatically tested by the contractor to a pressure of 300 pounds per square inch, in the presence and to the satisfaction of the local inspector of boilers, United States Steamboat-Inspection Service, or by representative of the contracting officer. The contractor shall make good to the satisfaction of the contracting officer any defects that may develop during the test.

Employee Education in England

THE facilities offered by the British railways for the education of employees are noteworthy, particularly since they have not restricted their efforts in this direction to the training of apprentices in the mechanical department, but have extended them to practically all departments. Before the amalgamation of all the railways into four regional groups, which took place on January 1, each company had its own plan. Naturally certain modifications were to be expected as the result of the consolidation and one of the first of these to be announced is the extension of the educational facilities offered to railway clerks of the Great Northern Railway to employees of that class of the entire London & North Eastern group. The courses of instruction are, in every case, conducted by local colleges and universities at various important railway points. The educational institutions provide the instructors and arrange the details of the work to be covered. The railway pays the greater part of the tuition and arranges for the furnishing of text books at reduced prices. For the forthcoming school term instruction will be offered in four subjects, viz., railway operation, the law relating to the conveyance of freight and passengers, railway and commercial geography and railway economics. Arrangements have so far been made for courses at eleven points along the company's lines. Each course consists of 20 lectures of one hour each and prizes are awarded by the company varying from $5 to $25, according to the standing of the student, for all who successfully pass the examinations given at the conclusion of each course. The continuance of these courses and their extension to all the railways of the group indicate that they have been successful in giving the employees a broad knowledge of railway work and in fitting them for promotion.—*Railway Age.*

Iron and Steel Exposition to be Held this Month

JOHN F. KELLY, national secretary of the Association of Iron and Steel Electrical Engineers, has extended to the readers of THE BOILER MAKER a special invitation to attend the Iron and Steel Exposition, being held at the Broadway Auditorium, Buffalo, New York, September 24 to 28, 1923.

Over one million dollars' worth of apparatus will be on display and will represent what 150 of the largest manufacturers in the United States have developed for the use of the industries during the past year.

A special feature will be the complete electrified foundry which will be in actual operation producing finished castings. Starting with the electric furnace, every operation known in modern foundry practice will be exemplified and as this is the first time that this feat has been attempted in America, it will attract thousands of foundrymen from all over the United States.

The technical sessions which are held in connection with the Iron and Steel Exposition have all been prepared with a view of imparting the practical experiences and data obtained by the engineers in the field of operation.

National Safety Council

THE National Safety Council will hold its twelfth annual Congress at the Hotel Statler, Buffalo, N. Y., on October 1, 2, 3, 4 and 5. The opening session is on Monday morning at 10 o'clock, when Marcus A. Dow, president of the council, will deliver his address. Another address on Monday will be that of H. A. Rowe, claims attorney of the D. L. & W., in the afternoon, on the careful crossing campaign. On Tuesday afternoon, there will be an exhibition of 100 new safety stereopticon slides, showing new developments in safeguarding. These will be presented by C. B. Auel. Another item of interest to railroad men will be a discussion, on Wednesday evening, of the bulletin board as an indispensable safety advertiser. Mr. Dow is scheduled to speak again on Tuesday afternoon, before the public safety session, on the work which he has been doing in the Bureau of Public Safety of the New York Police Department.

The foregoing are the principal items in the program which appear to be of special interest to readers of the THE BOILER MAKER, until we come to the steam railroad section. This section, of which L. G. Bentley, of the Chesapeake & Ohio, is chairman, is to hold sessions in the forenoon of Tuesday, Wednesday and Thursday. A dozen interesting topics are scheduled for discussion at these sessions but the speakers have not yet been announced.

W. E. Smith Selected by Boiler Code Committee

The A. S. M. E. Boiler Code Committee has recently appointed W. E. Smith, chief boiler inspector of the Boiler Inspection Department of the Hawaiian Sugar Planters Association, Honolulu, a member of its Conference Committee representing the Hawaiian Islands.

The Boiler Maker

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Early in the present year the American Railway Association outlined a definite plan for the railroads to follow in meeting the demands for motive power which seemed certain to arise during the summer and fall months. One of the resolutions adopted by the association provided that by October 1 locomotives requiring heavy repairs be reduced to a basis for the entire country of 15 percent.

At that time the number of locomotives in line for heavy repairs was about 21 percent with the majority of shops just beginning to recover from the strikes of the previous year. The prospect, therefore, for the realization of what would constitute a record for locomotive maintenance seemed rather hopeless.

With the approach of the fall season, however, the possibility of accomplishing the desired reduction in bad-order locomotives seems better. Available records indicate that from July 15 to August 1 the railroads of the United States repaired and turned out of their shops the greatest number of locomotives for any semi-monthly period in their history. During this period 22,200 locomotives were repaired exceeding by 794 the record previously made during the last two weeks in May of this year. The locomotives in need of repair on August 1 totaled 11,555 or 18.1 percent of the total number on the line. This was a decrease of 300 as compared with the number on July 15 when there were approximately 18.6 percent.

On August 1 the heavy repairs were reduced to 16.2 percent which indicates that as far as the boiler departments are concerned the record of 15 percent by October 1 will undoubtedly be realized. This fact is particularly interesting because of the necessity in many cases of training entirely new men for carrying on the shop work.

In meeting the heavy locomotive demand of the past few months many of the railroads have found their capacity inadequate for maintaining the repair schedules laid out for them. As a result, locomotives in increasingly greater numbers have been sent to contract repair shops which have been built up with the idea of accommodating the peak requirements of several roads in a given territory.

A description of a contract plant, with details of its development from a war-time ordnance plant, appears in another section of this issue. The location and arrangement of the shops, as well as the equipment, were readily adapted to locomotive repair work on an extensive scale. In fact in one respect this plant is superior to practically every locomotive shop in the country—that is in its crane equipment which is made up of many special type ordnance cranes, the cost of which for the usual repair shop would be prohibitive. With this equipment, however, the work is put through the shops with great dispatch.

The greatest difficulty in establishing the plant occurred in creating a skilled organization capable of maintaining the standards of the roads for whom repairs were contracted. To a large extent men engaged in the repair work are semi skilled rather than fully qualified mechanics. For this reason the work has been specialized in all departments under the direction of the superintendent of the locomotive repair department. About 80 percent of the men in the boiler shop for example were employed in various other capacities than boiler makers previous to their engagement with the company. Each man, however, has been taught to perform the operations assigned to him with great skill so that the specialization of the individual has more than compensated for the lack of all around boiler makers.

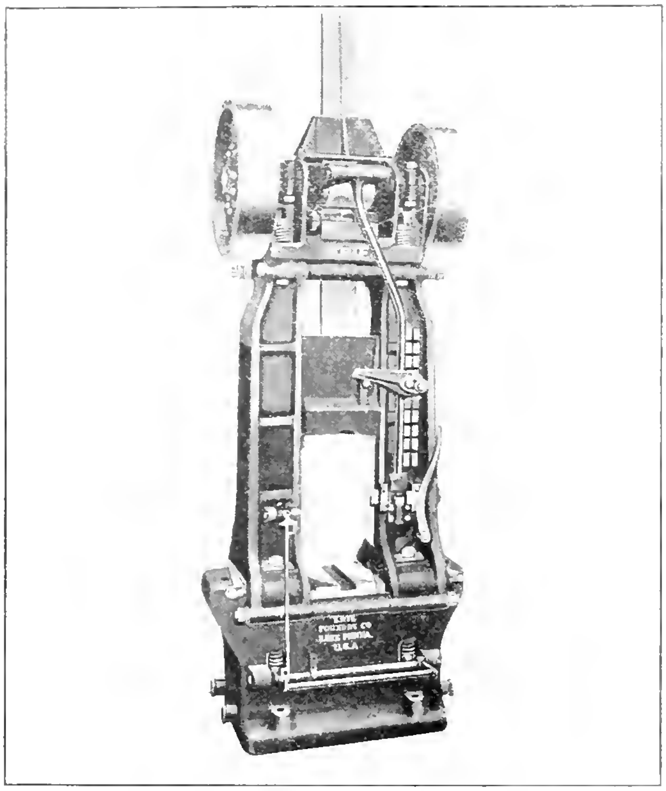
The showing made by the plant during the month of July of 40 heavy repairs is a creditable one and the system of contract shops such as this when operated efficiently offers a degree of relief to the railroads by providing facilities during peak periods when their own shops cannot accommodate all of their motive power without a great over expansion for the dull periods.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

High Production Board Drop Hammers

The Erie Foundry Company, Erie, Pa., has brought out a new line of board drop hammers, characterized by a refinement of detail rather than by any radical departure from accepted principles of construction. Many ideas developed by actual forge shop experience and now considered as standard in heavy steam drop hammer construction have been adapted to the new line of board drop hammers. A thorough study has been made of the troubles experienced with existing types and practical drop forgers consulted as to the best methods of correcting these faults, the idea of the builders being to achieve a machine capable of a high-rate of production at a minimum of operation and maintenance expense, and dependable even under the severe conditions to which drop hammers are subjected.



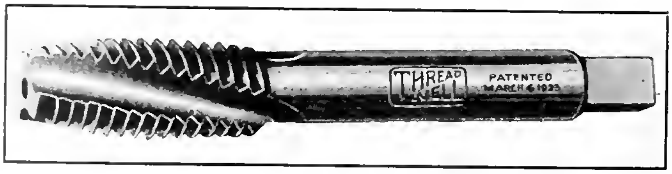
Erie Board Drop Hammer, Made in Sizes from 200 pounds to 4,000 pounds, inclusive

Among the outstanding features of the new hammers are wedge adjustment of the frames across the anvil, the use of tie bolts and separators between the frames at the bottom and a new type of latch. The wedges hold the frames and anvil together as a solid unit, making it easy to maintain the alinement of dies and at the same time making adjustment easier. The new type Erie hammer has a greatly increased tongue and groove area; also several details of the operating mechanism have been improved. The point of knock-off is easily adjusted, assuring that adjustment will be made as often as desirable and that the rolls will grip the board at just the proper moment. The friction bar drops vertically in guides, the latch bar being moved by the descending ram from under a block which fits against a shoulder on the bar. As the ram ascends, a hickory pin strikes one end of the roll release lever which is pivoted on a block clamped to the friction bar. Thus the friction bar is lifted gradually and without shock. The other end of the roll release lever bears on a pin which is adjustable up and down on a rack cast on the frame by means of which the length of strokes is varied. The crosshead construction used at this point reduces wear and shock.

The ram is an open-hearth steel casting, cast by a special process to assure a dense structure of clean metal. The main bearings are bushed with phosphor bronze, and ample bearing area is provided. The anvils can be furnished in the ratio of 15 to 1 or of 20 to 1 to the weight of ram. The pulleys can be of wood, paper, or steel, to suit individual requirements. The new line of Erie hammers is built in sizes from 200 lb. to 4,000 lb. weight of falling parts.

Spiral-Fluted Tap

A line of "Threadwell" right-hand spiral-fluted taps in which the thread is ground, is manufactured by the Wells Corporation, Greenfield, Mass., in nine screw-gage numbers from 2 to 14, inclusive, and ten fractional sizes from $\frac{1}{4}$ to 1 inch, inclusive. Each cutting edge has three points of clearance, due to the rake angle of the spiral, the rake angle of the hook in the flutes, and the clearance of the eccentric relief. The tap is said to be designed on the same principle as a properly ground lathe tool, and these clearances are similar in effect to the back rake, side rake, and under-cut clearance of a lathe tool. The right-hand spiral flutes curl the chips and convey them out of the hole.

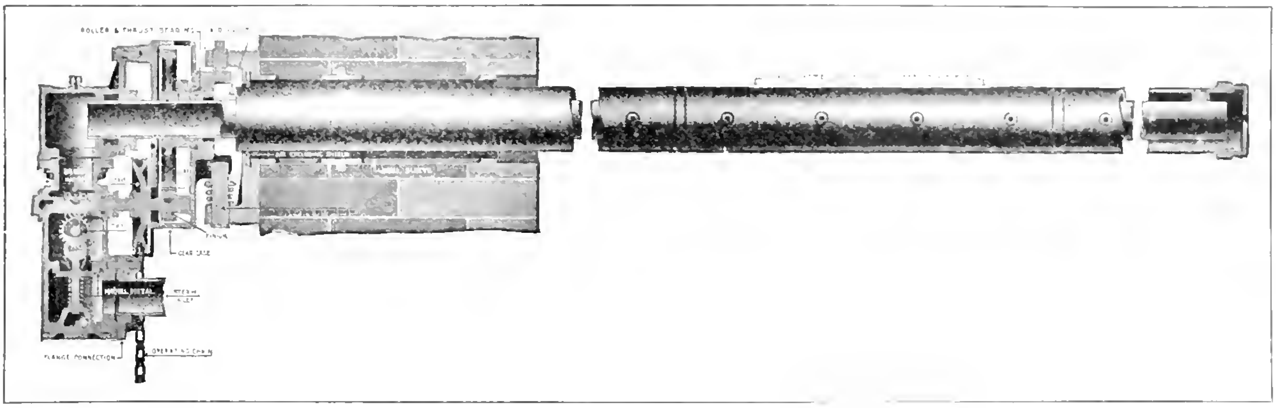


Wells "Threadwell" Spiral-fluted Tap

The tap is regularly made with a short "plug" chamfer for tapping all holes except blind holes where a full thread is necessary clear to the bottom. In such cases a very short chamfer is ground on the tapping end. In addition to the eccentric relief, an extra chamfer is given at the point where the taper and straight portions of the tap would otherwise meet. It is said that this double taper results in a more even distribution of the cutting strains and makes the tap less liable to breakage; in addition, less power is required for operating. The edges of the starting or chamfered threads are rounded, and all sharp corners removed to narrow the teeth and enable them to catch a thread without a reaming effect. Accuracy, both in diameter and lead, is guaranteed within 0.0005 inch.

Air Cooled Revolving Soot Blower

ONE of the latest developments in mechanical soot blowers has just been introduced by the Bayer Co., 4067 Park avenue, St. Louis, Mo. This device is sectional and, being made from monel metal, or charcoal iron as conditions require, is claimed to be non-warpable. Cooling is accomplished by air. The revolving soot blower unit is regularly furnished equipped with a geared head without valve. The geared head is completely encased, no parts being exposed to dust or grit. As the head is full floating it has freedom of movement in any direction. A reduction gear makes it impossible to revolve the unit too rapidly.



Cross Sectional View of the New Sectional, Air-Cooled, Revolving Soot Blower Unit

In the accompanying illustration is shown a cross-sectional view of the blower equipped with the valve. The outer sectional air tube is joined together by means of expansion sleeves which allow for expansion and contraction. The monel metal nozzles are secured to the interior steam element, expansion space being left around each nozzle where it comes through the outer or sectional air tube. Discharge or blowing of the steam jets is mechanically timed and the jets are blown within a predetermined arc. Rotation is possible in either direction, the movement being controlled by a light chain and a sheave wheel mounted on the head.

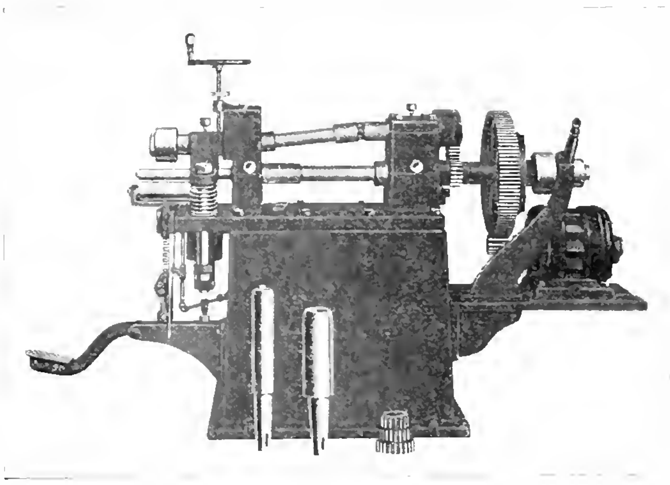
One of the features claimed for the blower is the accessibility to the valve and other operating parts. The valve mechanism is reached through a cap at the bottom of the blower head without the necessity for breaking any steam connections. Steam connections can be made in a horizontal position or any other way desired for convenience or to save piping.

Roller Type Flue Welder

WHAT is known as the Marshalltown-Schaefer flue welder has recently been developed by the Marshalltown Manufacturing Company, Marshalltown, Iowa. A distinctive feature of this welder is the use of two revolving rolls, one inside and one outside of the flue, between which the weld is made. These two rolls are power driven at a comparatively slow speed and are connected by gears, the ratio of which causes both rolls to operate at the same circumferential speed.

The illustration shows the welding machine alone. With it, however, are furnished a 550-pound anvil with a cone-shaped horn for belling the ends of the flues preparatory to receiving the safe ends, and a ball and roller bearing stand to support the outer ends of the tubes while in the welding machine. After the tube has been prepared to receive the safe end and heated with the safe end in place, the weld is made on the machine by slipping the heated flue and safe end over the lower mandrel or inside roller and bringing the weld under the upper or outside roller. A stop can be provided on the mandrel by placing a short piece of flue of the proper length on the back of the arbor. With the rollers in motion, the upper roller is brought down in contact with the flue by means of an air cylinder operated by the foot lever shown in the illustration. This lever is first pressed lightly while the flue makes two or three revolutions. The pressure is then increased, causing the two rounding rolls shown in the illustration below the inside mandrel, to move up against the flue. Care must then be taken not to continue the rolling too long or the size of the flue may be enlarged. With the roller bearing adjusted so that it is in line with the inside mandrel, the revolving of the flue while the weld is being made alines the flue and the safe end so that when the weld is complete the whole piece is straight.

The machine has a welding range which will take tubes from 2 to 6 inches in diameter by changing the rolls, and pieces up to 9 inches in length can be welded on the flue. Three sets of rolls are furnished with each machine and a small hand wheel adjustment is provided at the top so that the welding roll may be correctly set about 1 inch above the mandrel in each case.



The Marshalltown-Schaefer Flue Welder

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Transition Piece Intersecting a Cylinder

Q.—Inclosed please find clipping from a drawing which I have had no small amount of trouble trying to develop. You will note the sections I refer to are marked "I" and "I-A."—J. H. S.

A.—In the development of intersections of this character it is necessary to develop three views of the connecting object, as indicated in Fig. 1. The plan and side view will appear the most difficult since there are two steps in the development for obtaining the miter line. These will be understood from the explanation.

The outline of the transition piece and the cylinder in the end and side views are drawn first, then the circle in the plan which represents the upper base of the object. The next step is to produce the shape of section as taken on the plane x-x of the elevation as follows: Divide the circle plan view into the desired number of divisions as from 1 to 7; likewise with the semi-circle drawn from point s of the end view. With *t-1* and *t-7* of the elevation as radii draw the quadrants shown. Divide each of these areas into three equal parts, locating points u, v, w, y which are projected to intersect the lines drawn through the points m, n and o of the plan. The dotted outline is the shape of the section on x-x.

The points u, v, w and y are located on the plane x-x of the elevation. Lines are then drawn connecting points *2-y*, *3-w*, *5-v* and *6-u* as indicated in the elevation for the parts A and B. From the end view projectors are extended to the side view intersecting the radial lines as shown in the points *2*, *3*, *5* and *6* which lie on the miter line.

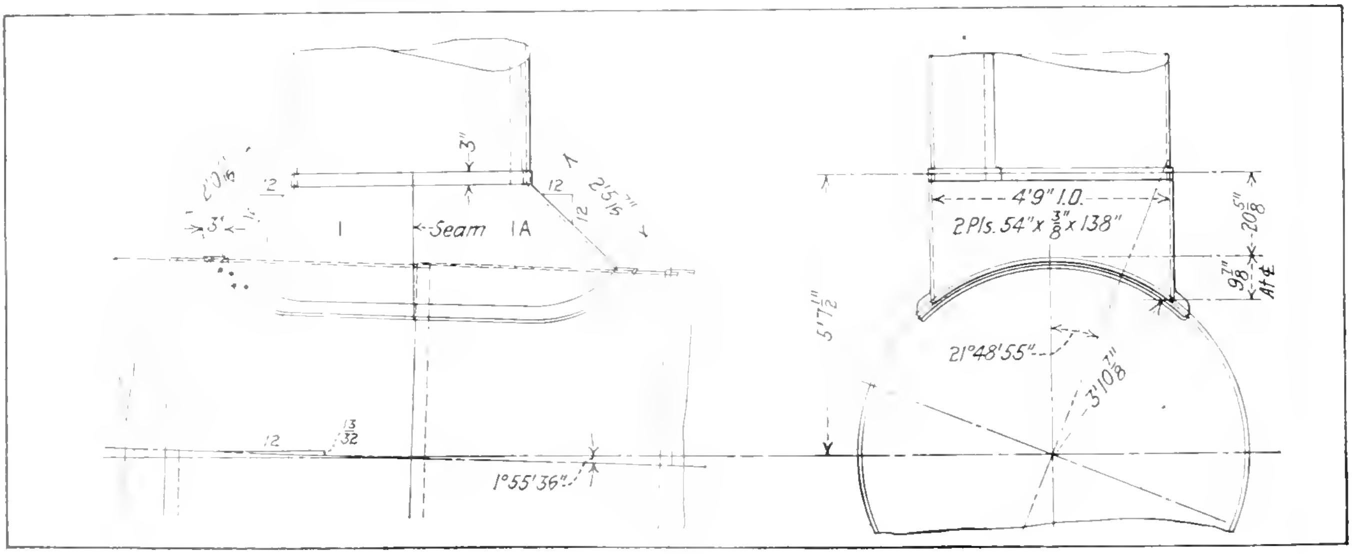
The points located on the miter are then projected to the plan view to locate their relative position as indicated at *1'*, *2'*, *3'*, *4'*, *5'*, *6'* and *7'*. The solid line through these points represents the line of intersection in the plan.

In the elevation, dotted diagonals are shown for which their true lengths must be found as shown in Fig. 2. Use the heights a, b, c of the elevation, Fig. 1, transferring them as shown in Fig. 2. The bases of the respective triangles are taken from the plan using the dotted lengths *1-2*, *2-3*, *3-4*, *4-5*, etc.

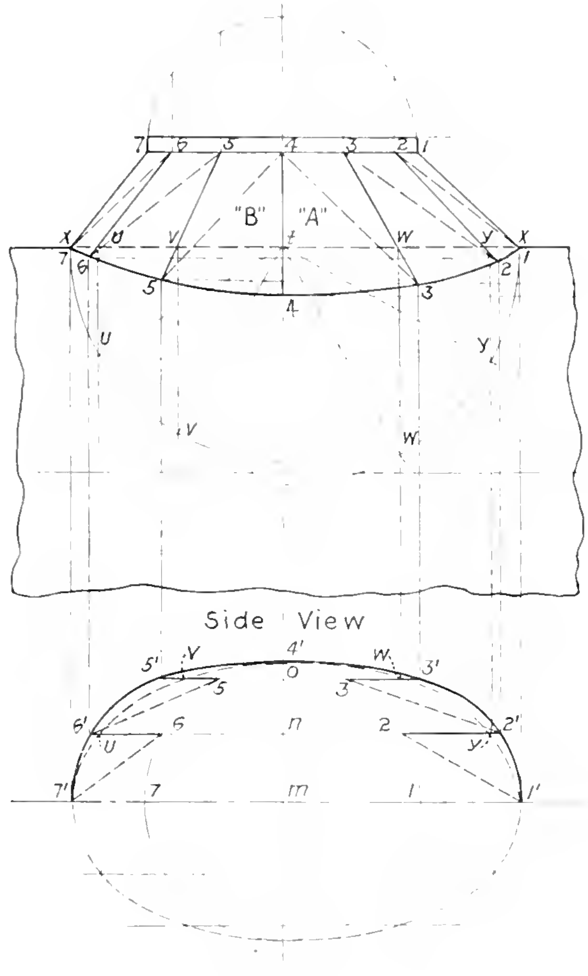
The solid lines *1-1*, *2-2*, *3-3*, *4-4*, etc., of the elevation are shown in their true lengths in this view, as their corresponding projections in the plan are parallel with the horizontal axis *1'-7'* or in other words parallel with front plane.

Before the patterns for A and B can be laid off, it is necessary to obtain the true arc lengths on the miter line. This may be done by developing first the shape of the opening where the transition piece intersects the cylinder as represented in Fig. 3. In this view, lay off on the line *4-4* the arc lengths *1'-2'*, *2'-3'* and *3'-4'* of the end view, thus locating the points m, n and o through which draw straight lines at right angles to line *4-4*. Transfer from the plan, Fig. 1, *m-1'*, *n-2'*, and *o-3*, and locate these lengths in Fig. 3, likewise, transfer the lengths *m-7'*, *n-6'* and *o-5'* from the plan, Fig. 1 to Fig. 3, which gives the location of the points *1*, *2*, *3*, *4*, etc. The outline of the opening is then drawn in.

The pattern for section A is given in Fig. 4 and for B in



Details of Transition Problem



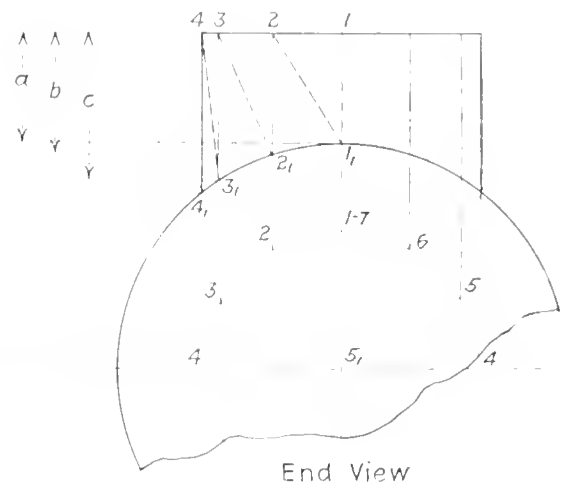


FIG. 1-Showing Three Views of Intersection

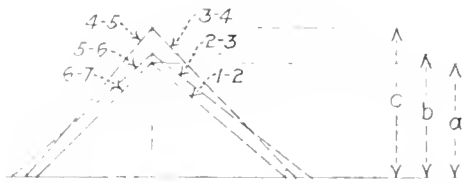


FIG. 2-True Lengths of Dotted Diagonals

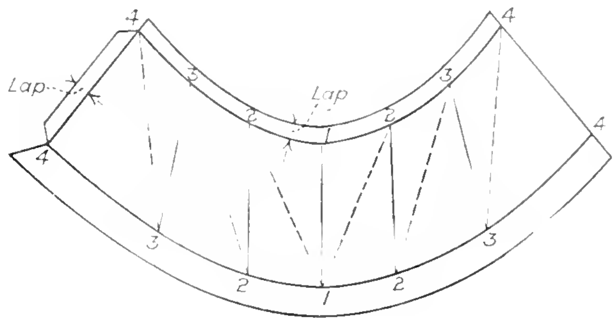


FIG. 4-Pattern of Section "A"

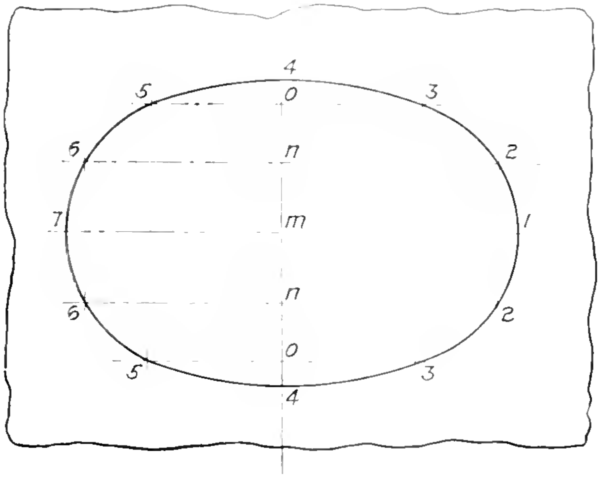


FIG. 3-Development of Opening in the Pattern for the Cylinder

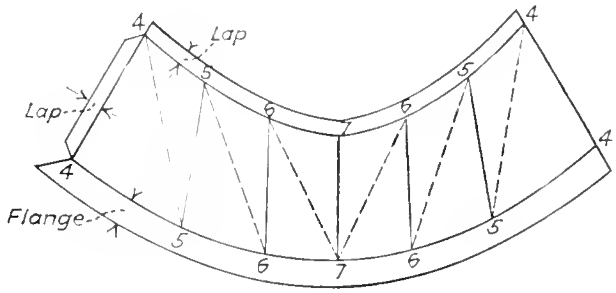


FIG. 5-Pattern of Section "B"

Layout and Patterns of Cylinder and Transition Piece Intersection

Fig. 5. The layout work for these consists of transferring the solid lines of the transition piece, Fig. 1, the dotted lines, Fig. 2 and using the arc length of the upper base as indicated in the end view, Fig. 1, together with the arc lengths of the opening outline shown in Fig. 3. Make the necessary allowances for lap.

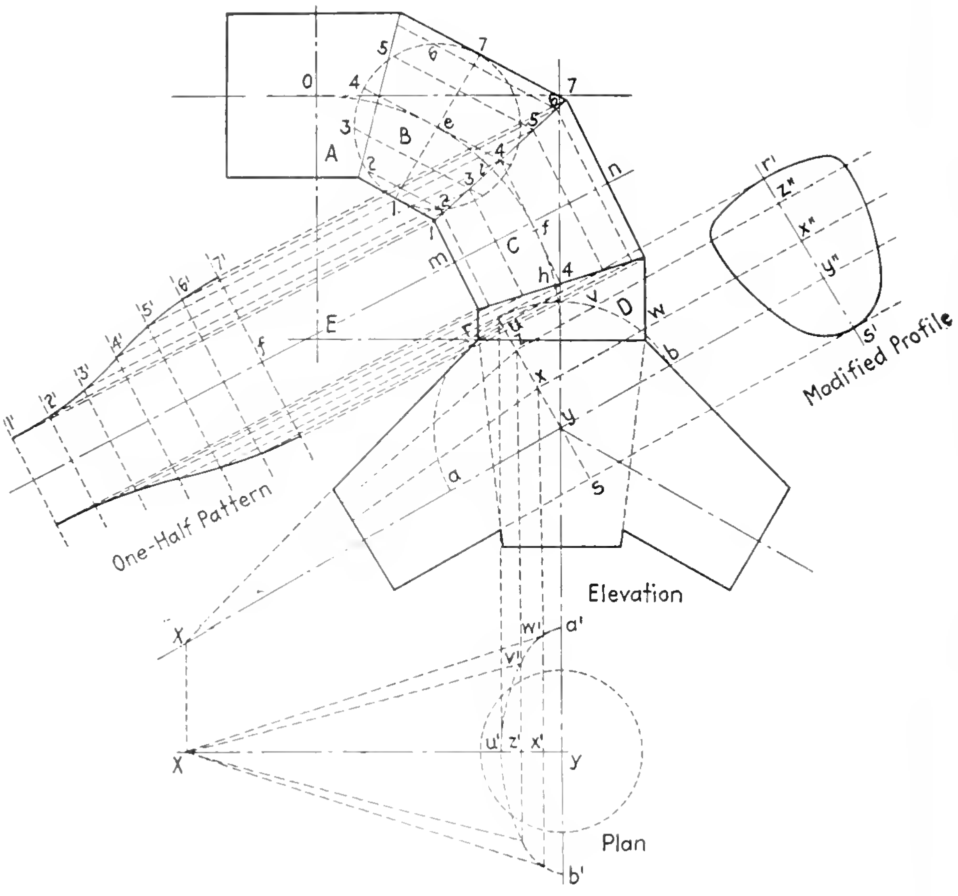
Elbow and Tapering Problem

Q.—Please explain and show by development how the connections and patterns are made for the elbow sections shown in the accompanying sketch —W. T.

A.—The elbow pattern is obtained by first laying off an elevation of the elbow sections. Divide the arc *o-p* into one less than the number of required sections, as *o-e*, *e-f* and *f-p*. Bisect arcs *o-e* and *f-p* as shown at *g* and *h*, respectively. Bisect the arc *g-h* at *i*, thus locating points for drawing radial lines to E. On these radials the miter between the elbow sections are located. Lines *4-4* are drawn tangent to the arc *o-p*. With *e* as a center, a circle is drawn equal to the diameter of the elbow. It is divided into a number of equal parts. Lines parallel to center line *4-4* are drawn from the points 1-2-3-4, etc., of the circle so as to intersect the miter lines.

A one-half pattern is developed on line *m-n*, from point *f*-6 equal divisions are set off equal to the arc lengths between points 1-2-3-4, etc., of the profile. Projectors are drawn at right angles to *m-n* and the points 1-2-3-4-5-6-7 projected to the pattern, parallel with *m-n* locating 1′-2′-3′-4′, etc. The other half is the same as the one shown developed. Patterns for the end sections *A* and *D* equal one half of the sections for *B* or *C*. Make the seams so that they are staggered with respect to each other.

The tapering connection cannot be laid off as frustums of cones. It appears from the original drawing that the bottom part of the branches are of a semi-cylindrical shape and that the upper part was intended for a section of a cone. Making the upper part that way, you will note that it would not intersect the center piece properly and as will be seen from the partially developed plan. Note the reference letters in comparing the two views, the one-half ellipse is a development of the base of the one-half cone. The elements of the cone section do not touch the surface of the center frustum. In order to make the development the base connections of the branches will have to be modified to suit the conditions or the cone sections must be made smaller. If they are modified as shown to the right of the elbow triangulation must be used in laying off the miter line and pattern.



Layout and Pattern for Blower Connection

PERSONAL

R. C. Young has retired as boiler shop foreman on the Chicago & Northwestern, at Baraboo, Wis., and is placed on the pension list, after being with the company almost 40 years.

Flanging Blocks

Q.—Can you advise me as to how much flare to allow on flanging block to flange a straight head 14 feet 6 inches diameter; ⅝-inch metal with 8½-inch flange, same to be at right angle to face of head, and, as we are considering installing a gas burning furnace, will you kindly give any information you have concerning same.—W. G. K.

A.—Your inquiry on the flare is not quite clear. In flanging with formers under hydraulic pressure the plate follows the shape of the male former, therefore for all such work the face of the flanging die or blocks is made at right angles to the plane of the plate. In cold bending light sheet steel, some flare allowance for the male die is made to take care of the spring in the plate. In hot bending the flare is not necessary as the hot bend makes a permanent set in the bend. Where contraction affects the flange in cooling it is set in or out by hand as required.

The problem of furnace design and construction for heating the plate should be handled by experienced contractors, and we would suggest that you write to the American Shop Equipment Company, Chicago, Ill., or Rockwell Furnace Company, 50 Church Street, New York.

Emergency Boiler Tube Stopper

ONE of our subscribers has asked for information on a self-acting emergency tube stopper for firetube boilers which, when inserted, will expand and close both front and back ends of the tube without the necessity for drawing the fire and going to the back end of the boiler to adjust the stopper.

If any of our readers are familiar with a device of this particular kind and where it may be obtained, we will appreciate his kindness in forwarding the information to us.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Testimonial Letters on Fuel Saving

We are so accustomed to reading testimonial letters on fuel or money saving by the use of more modern equipment that such letters lose their intended effect. We are inclined very often, to doubt their veracity, especially when large savings are claimed. It is always so easy to exaggerate. Nevertheless, it is a fact that considerable fuel and money are commonly saved by replacing old equipment with something more modern and more efficient. It is becoming a very difficult task to convince owners of central stations, heating plants and industrial plants in general that this is true.

To assist the manufacturer of modern equipment in proving his claims and to stimulate more confidence on the part of the owners and officials of fuel buying and consuming plants I quote this from a small weekly newspaper, the Brookings, South Dakota, *Register:*

"Before the new boilers were installed the plant consumed about 260 tons of coal a month. Since the new boilers have been installed the consumption has been around 200 tons a month, a saving amounting to about $700 a month ever since the new equipment was put in operation."

These boilers are installed in the municipal power plant belonging to the citizens of the city of Brookings. The figures are absolutely true.

And to make it still more interesting the writer knows that the power plant is now doing considerable MORE work as current is being furnished to a neighboring village, Volga, South Dakota.

Newark, N. J. N. G. Near.

Saw Mill Boiler Explosion Fatal

On Thursday morning, April 5, at ten A. M. a boiler exploded in a saw mill four miles east of Huntingburg, Ind., instantly killing Mr. Frank Pfaffs, owner, and injuring his son, Hubert, and Joe Mattingly who were working in the mill at the time tightening a pulley. The mill had just been shut down a few minutes before the accident on account of the loose pulley.

The son, Hubert, gave the following version of the accident: The boiler had recently been subject to a hydrostatic test of 165 pounds and found tight, but after the test was made the mechanic suggested that the safety valve be set to blow at 135 pounds. This they decided to do, but apparently their steam gage was not correct as the safety valve opened at 140 pounds by test after the accident. About the time the mill stopped the father went in the mill to assist the man in repairing the loose pulley, but the son noticed a small leak on the bottom of the boiler, calling this to the attention of his father, who went to investigate: just about the time he got to the back end, the boiler exploded.

On examination I checked the following: Length of boiler, 10 feet 6 inches; diameter of boiler, 34 inches; thickness of plates, ¼ inch, all but tube sheets which are 5/16 inch; pitch of rivets, 2¼ inches; diameter of holes, 11/16 inch; diameter of staybolts, ¾ inch; pitch of staybolts, 5 inches by 5 inches; diameter of dome, 16 inches; thickness of dome, ¼ inch, single riveted; head, cast iron; all plates of steel, 60,000 pounds tensile strength. The boiler was 12 years old and had been worked continuously at 150 pounds until recently. The tubes were 5 feet 6 inches long and 2 inches diameter, the safety valve was 1¼ inches diameter.

By referring to the illustrations the results are apparent. The cause was evidently grooving of the plate along the calking edge inside about 36 inches long and 3/16 inch deep (see small photograph of pieces cut out of ends). The boiler moved back about 12 feet: the firebox turned over: apparently the cylinder made a double turn, as a close study will show that the seam was on the bottom. The seam opened the entire length, tearing through the throat sheet and down a few inches, then straight across, then up around, about 2 inches back of the girth seam, apparently meeting near the center on the top. The wagon top sheet was ripped towards the back end about 6 inches. The front tube sheet and cylinder did not separate completely as ten rivets on the top were intact. All the other rivets were pulled through the holes. Note the bearing castings, those were on the top back of the dome. It is evident that this plate straightened out and then curled as shown.

The boiler evidently was thrown almost straight up in the air as the face of the man killed was mashed in and he was

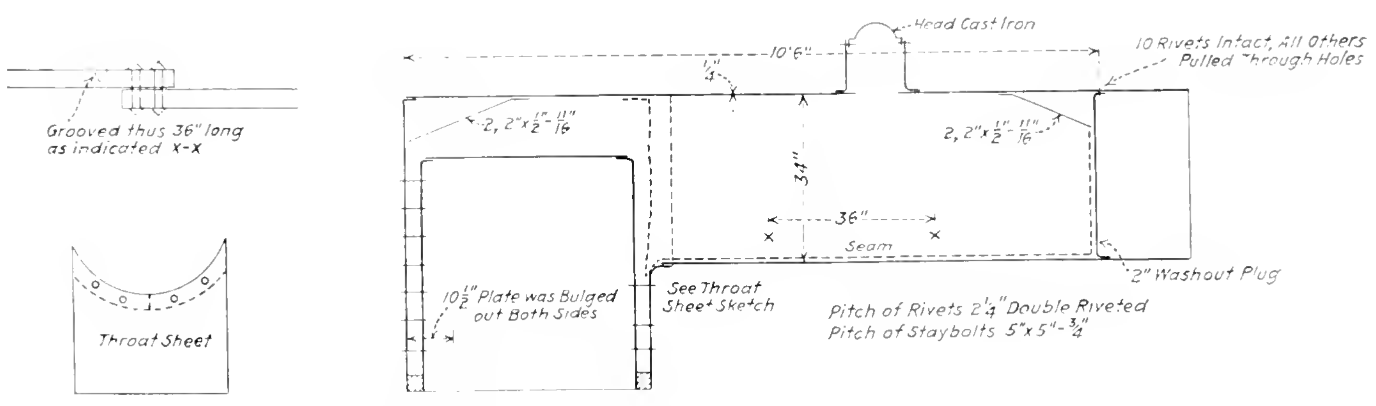


Fig. 1.—Diagrammatic Details of Boiler and Line of Failure

Fig. 2.—Scene of the Wreck. Grooving Along Calking Edge of Plate Responsible for Failure. (See Insert)

found in the open space in front of the wreck.

A thorough hammer test in connection with the hydrostatic test might possibly have revealed the weakness as the metal was not over 1/16 inch thick at the bottom of the groove.

Evansville, Ind. INSPECTOR.

Explosion of Vertical Boiler

UNDER the foregoing caption your correspondent, Mr. J. P. Morrison, of Chicago, Illinois, reports an explosion of a vertical tubular boiler (page 213 of the July issue of THE BOILER MAKER) and gives certain figures relating to the part of the boiler that failed, viz., the furnace sheet which was supported by 3/4-inch diameter staybolts pitched 8 inches by 8 inches apart.

It is not the writer's intent to criticize Mr. Morrison's letter except to say that your readers in general would probably be glad of more information regarding the details of construction and incidentally to comment a little on the action which produces the erosion or wasting away of the outer sheet adjacent to staybolts.

Concerning the shell construction, Mr. Morrison is silent so one can only make calculations from assumptions, but these seem to point to excessive pressure. Thus, with 1/4-inch shell, 55,000 pounds tensile strength, diameter 44 inches, and assuming the maximum efficiency possible, 77 percent, for double riveted lap joint with 11/16-inch holes on 3-inch pitch, we have—

$$\text{Bursting Pressure} = \frac{0.25 \times 55{,}000 \times 0.77}{22} = 481$$

pounds.

If a factor of safety of 5 be used, the safe working pressure would be only 96 pounds. In other words, the boiler was operating at more than 30 percent excess pressure, and by dividing the bursting pressure by the pressure carried, we have $\frac{481}{125}$ = a factor of safety of 3.84, on the highest possible joint efficiency. As a matter of fact such a joint is by no means common on account of the difficulty in calking a 3-inch pitch. Consequently it is probable the actual factor of safety in this case was much nearer 3 than 4. It is providential, in view of the proximity of persons at the time of the explosion, that the failure did occur in the firebox, thus expending the pent up forces downward instead of outward as would have happened if the outer shell had ruptured.

It is noted that Mr. Morrison attributes the deterioration of the sheet adjacent to the staybolt to feed water action, but the writer has frequently noted and believes that it is more likely caused by the constant bending action on the staybolts produced by the greater expansion of the furnace sheet and tubes since these are subjected to higher temperatures than is the outer shell plate.

True, this action is most often found at the junction of staybolt and outer shell, and is doubtless assisted by some feed waters, but where the fire action on staybolt heads, coupled with expansion, has caused slight leaks to occur, the staybolt hold on the fire sheet is soon weakened, thus leaving the furnace to carry almost the entire collapsing load.

Using the Code as a guide, and disregarding the 5/16 inch minimum thickness required, this furnace had a right to be figured without staybolts, since it can hardly have been over 38 inches diameter. Once more resorting to assumption and judging from Fig. 1 (page 213, July issue), which shows 2 rows of staybolts, the furnace was probably about 25 inches in length.

The Code formula for such a furnace would give:

$$\frac{51.5}{D}\left\{(18.75 \times t) - (1.03 \times L)\right\}$$

$$\frac{51.5}{38}\,(75.00 - 25.75)$$

$$1.355 \times 49.25 = 66.7 \text{ pounds.}$$

If now one adds the 34 pounds safe working pressure on the staybolts to the safe working pressure on the furnace, it will be seen that a pressure of 100 pounds is obtained and that theoretically at any rate, the outer shell was probably the weakest part of the boiler.

Whenever possible, the writer prefers to go a step further than Mr. Morrison recommends and urges boiler users to invariably call in a recognized inspector whenever any boiler is to be retubed or major repairs are to be undertaken because it usually affords an opportunity to view surfaces that are otherwise inaccessible.

Numerous instances have occurred in the writer's experience where it has been conclusively shown that the expense of retubing or repairs was unwarranted by the conditions revealed.

San Francisco, Cal.

R. L. Hemingway,
Chief Boiler Inspector,
California Industrial Accident Commission.

Mr. Morrison's Reply

To the Editor, The Boiler Maker:

I APPRECIATE the privilege afforded by the kindness of The Boiler Maker and our friend, Mr. R. L. Hemingway,. of reviewing his comments on the article referring to the explosion of the Vertical Tubular Boiler which appeared on page 213 of the July issue of The Boiler Maker. Mr. Hemingway's assumptions with respect to the strength of the longitudinal seam of the boiler which exploded are substantially correct.

There is no doubt that the pressure carried was in excess of that permitted by modern practice regardless of whether the staybolting of the firebox or the riveting of the vertical seam be considered, but it was the firebox failure which resulted in the destruction of the boiler and which was the subject of the July article although the seam construction may not have received the attention due it. Considering the strength of the seam in connection with the explosion which resulted from the failure of the firebox is somewhat like testimony which was presented in a murder trial. The fact that the defendant disliked his mother-in-law and abused his wife was not considered competent and did not furnish proof of his guilt or innocence of the murder, although his domestic relations may not have been all that they should have been.

However, as the boiler design was faulty and the pressure carried was considerable in excess of the safe limit, the explosion is just what might have been expected.

Safety of Second Hand Boilers

On account of the immense building program and the highway construction activity being carried on at this time, small vertical tubular boilers are in great demand, so the second hand dealer can depend on a "quick turnover."

Such boilers used in construction work are seldom under insurance inspection supervision. Some of our states have no boiler laws, others exempt from the law boilers used in road and railroad construction work, boilers used exclusively for agricultural purposes and boilers used in the oil fields. Then, too, a portable boiler may be used for some time before those in authority and having jurisdiction may have any knowledge of its presence, as any legal requirement giving the owner the duty of notifying the state inspection department of the location of such a boiler is often not taken very seriously. So there is a great number of old portable boilers of the vertical tubular and of the locomotive types being operated without any inspection supervision and at pressures which sooner or later will cause failure of a more or less violent nature.

Requirements in the State of Michigan

At least one State Board of boiler rules (Michigan) requires the authorization of the transaction before a used boiler can be disposed of. This rule, adopted on June 15, 1922, is found in Appendix 3 of Paragraph 3 of the 1923 edition of the Michigan Boiler Rules and is as follows:

"No person, firm or corporation shall sell or offer for sale any second hand boiler for use as a steam boiler without authorization from the Board of Boiler Rules, Department of Labor and Industry."

The Michigan Board of Boiler Rules has also the authority to formulate regulations requiring persons, firms or corporations doing boiler repair work in the state of Michigan to report to the Board of Boiler Rules on such work that "repaired boilers may be properly inspected and the public safety thereby assured."

For various reasons it is not possible to have rules of this kind applied in every state of the union and as laws do not stop all theft or murder, there will be some evasions which may be discovered only after the explosion occurs and it was the purpose of the article appearing on page 213 of the July issue of The Boiler Maker to bring the repair shop's attention to the work they may do toward improving conditions as much as possible, although the practice of having a commissioned inspector examine the boiler thoroughly while repairs are under way is a good one, it cannot be followed in case there is no boiler law or where boilers of the type to be repaired are not under the state's jurisdiction.

Reverting to the exploded boiler and the strength of its furnace we must bear in mind a minimum plate thickness of 5/16 inch is now required so the code rules for determining the pressure which would have been approved on the boiler in question do not apply, but in order to avoid any misunderstanding which might result from Mr. Hemingway's furnace calculation I would call attention to the fact that it is not permissible to add the strength of the stays, as determined by 1918 Code, Paragraph 220c and Table 5, to the strength of the unsupported furnace sheet as determined by the calculations outlined in the 1918 Code, Paragraph 239a and b. Code interpretation 256 indicates a furnace in excess of 36 inches in diameter in a vertical firetube boiler must be stayed as a flat surface, and Code interpretation 277 refers to the use of Table 4 and Paragraph 212c in discussing the same subject. However, in the 1918 Code Paragraph 212c was nullified by the Code Committee (see *Mechanical Engineering*, February, 1921, page 139), and new paragraphs to appear in the 1922 revised code, as paragraphs 212c and 212d are being used. The revised paragraphs referred to make some allowance for the curved sheet's ability to resist collapsing stresses but not to the extent of the pressure which would be permitted on an unstaybolted furnace when calculated by Paragraph 239.

The cause or causes of the corrosive action which decreases the thickness of steel plates from the water side have been the subject of considerable research and much discussion; and there continues today about as much difference of opinion as when the action was first observed. There seems to be a pretty well founded opinion that the grooving around staybolt holes is in a measure the result of the stresses set up in the plates by the hole punching process. The reamer end of the staybolt tap cannot be depended upon to remove all of the affected material. No doubt the stresses due to temperature and pressure changes contribute their share but feed water conditions are undoubtedly responsible for the action which weakened the furnace sheet of the vertical tubular boiler which exploded at Algoma, Wisconsin, and similar conditions have affected a considerable number of boilers of that description which, however, had sufficient stays to provide an ample margin of safety to prevent a violent failure of the furnace before the leakage at the staybolt end gave warning of the sheet's weakened condition. This corrosive action is quite common where water containing considerable sulphur—from the coal mines for instance—is used.

Chicago, Illinois. J. P. MORRISON.

BUSINESS NOTES

John E. Cunningham, Jr., has been appointed assistant manager of the production department of the Schenectady works of the General Electric Co.

R. W. Benson, eastern representative at New York City of the Flannery Bolt Company, Pittsburgh, Pa., has resigned, and the company has closed its eastern office at 41 East Forty-second street, New York City.

F. Lee Townsend, formerly assistant boiler engineer at the Delaware Station of the Philadelphia Electric Co., has accepted a position with the Westinghouse Electric & Manufacturing Co. at the Philadelphia sales office.

The American Car & Foundry Company has purchased a tract of land 260 feet by 1,931 feet extending from the south branch of the Chicago river almost to Blue Island avenue and fronting on Wood street, Chicago, from the Edward Hines Lumber Company.

Graham Bright, formerly General Engineer in charge of the coal and metal mining activities of the Westinghouse Electric & Manufacturing Company, has joined the firm of Howard N. Eavenson & Associates, mining engineers of Pittsburgh, Pa. Mr. Bright will give special attention to power house systems, power plant appraisals, transportation and transmission systems for coal and metal mines, and general industrial power applications.

A number of changes have been made in the personnel of the district offices of the Westinghouse Electric & Manufacturing Company. A. D. Stewart has been appointed branch manager of the Butte, Mont., office, succeeding R. J. Cobban, who has been transferred to the Seattle office. L. C. LaMont has been appointed office manager of the Los Angeles office, succeeding J. R. Deering who has resigned. A. G. Crocker, formerly special power representative, has been appointed manager of the industrial division of the Detroit office, succeeding E. A. Wooten who has been assigned to other work.

Locomotive Shipments and Orders on Hand

The following table was prepared by the Department of Commerce showing July shipments of locomotives from the principal manufacturing plants, based on reports received by the Bureau of the Census from the individual establishments:

LOCOMOTIVES

	July, 1923	June, 1923	July, 1922	Seven months' total January to July 1923	Seven months' total January to July 1922
Shipments					
Domestic	211	221	122	1,543	342
Foreign	28	11	6	101	148
Total	239	232	128	1,644	490
Unfilled orders (end of month):					
Domestic	1,652	1,854	712	...	...
Foreign	86	104	99	...	...
Total	1,738	1,958	811	...	...

Boiler Inspection Act

The Circuit Court of Appeals, Sixth Circuit, holds that, while the Interstate Commerce Commission is authorized to make rules and orders in furtherance of the enforcement of section 2 of the Boiler Inspection Act, requiring boilers in operation to be in proper condition, the failure of the Commission to make a rule or order covering every defective condition or construction within the meaning of the section does not relieve the railroad from complying with its provisions.—Baltimore & Ohio v. Groeger, 288 Fed. 321.

TRADE PUBLICATIONS

RIVET FORGES.—A 4-page illustrated bulletin, No. 504, describing a new suction feed type Venturi fuel oil-burning rivet forge, has recently been issued by the Hauck Manufacturing Company, Brooklyn, N. Y.

ZINC ROOFING.—The New Jersey Zinc Company, New York, has issued a small leaflet outlining the adaptability of standing-seam Horse Head zinc roofing for many types of buildings. The leaflet is illustrated with sketches showing how the roofing is applied.

PORTABLE OIL HEATERS.—A 16-page illustrated bulletin, No. 503, describing the latest Venturi oil-burning torch for making locomotive steel car and rip track repairs, has recently been issued by the Hauck Manufacturing Company, Brooklyn, N. Y.

ALTERNATING CURRENT MOTORS.—The Reliance Electric & Engineering Company, Cleveland, Ohio, has just issued a 14-page illustrated bulletin, No. 5018, descriptive of its new line of Type AA induction motors for two and three phase alternating current circuits. These motors, which are of the squirrel cage type, range in sizes from ½ to 25 hp., and in speeds from 900 to 1,800 r.p.m.

RIVETERS.—The Hanna Engineering Works, Chicago, has recently issued a 64-page illustrated booklet, Catalog No. 5, fully describing the design and construction of its compression yoke riveters, which range in sizes from 4 in. to 21 ft. reach, and in capacities from 10 to 150 tons. These riveters are particularly adapted for use in the boiler, tank, structural, bridge, car, and steel shipbuilding industries.

A TEST OF INTEGRAL WATERPROOFING.—In an eight-page folder issued by the Truscon Laboratories, a report is presented of tests made by Samuel R. T. Very, architect, on the increased impermeability of concrete containing an integral waterproofing compound. The report is presented in an entertaining way with no similarity to the exceedingly prosaic style commonly used in reporting such tests. The conclusions obtained are also presented in a concise way so that the busy reader has no difficulty in getting at the fundamental facts. As pointed out in the report, the tests were conducted so as to approximate as nearly as possible the kind of workmanship commonly obtained in actual concreting rather than that secured under laboratory conditions.

OIL STORAGE SYSTEMS.—An attractively prepared bulletin containing 49 8-in. by 10-in. pages devoted to oil storage systems has been issued by S. F. Bowser & Co., Inc., Fort Wayne, Ind. This bulletin is intended primarily for reference by railroad men who have to deal with the pumps, tanks and devices used in storing or handling oils, gasoline and other liquids. Clear-cut illustrations in color accompanied by appropriate descriptive data are given in various parts of the equipment, including agitators, agitator tanks, barrel-filling equipment, carload storage tanks, gravity-filling devices, measuring systems, oil pumps, mixing tanks, self-measuring pumps, signal oil pumps and out-pits, and many others. Several interesting illustrations are included of oil supply cars which are now in satisfactory service, effecting important economies in handling and supplying oils to outlying points. The bulletin explains the advantages of Bowser equipment in economy, convenience, safety, dependability and long service.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—A. G. Pack, Washington, D. C.

Assistant Chief Inspectors—J. M. Hall, Washington, D. C.; J. A. Shirley, Washington, D. C.

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

Vice-Chairman—D. S. Jacobus, New York.

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—W. E. Murray, Seattle, Wash.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Frank, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.

Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.

James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.

H. J. Norton, International Vice-President, Alcazar Hôtel, San Francisco, Calif.

International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Master Boiler Makers' Association

President—E. W. Young, mechanical assistant to G. S. M. P., C. M. & St. P. R. R., 787 Caledonia Place, Dubuque, Iowa.

First Vice-President—Frank Gray, tank foreman, C. & A. R. R., 705 W. Mulberry Street, Bloomington, Ill.

Second Vice-President—T. F. Powers, System G. F. Boiler Dept., C. & N. W. R. R., 1129 S. Clarence Avenue, Oak Park, Ill.

Third Vice-President—J. F. Raps, G. B. I., I. C. R. R., 4041 Ellis Avenue, Chicago, Ill.

Fourth Vice-President—W. J. Murphy, G. F. B. M., Penn. R. R. Lines West, 3614 Mexico Street, N. S., Allegheny, Pa.

Fifth Vice President—L. M. Stewart, G. B. I., At. Coast Lines, Box 660, Waycross, Ga.

Secretary—H. D. Vaught, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley R. R., 537 Linwood Avenue, Columbus, Ohio.

Executive Board—E. J. Reardon, Locomotive Firebox Company, 632 Marquette Building, Chicago, Ill., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn Avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—George R. Boyce, A. M. Castle Company, Chicago, Ill. Vice-President—J. P. Moses, Jos. T. Ryerson, Chicago, Ill. Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—E. R. Fish, Heine Boiler Company, St. Louis, Mo.

Vice-President—E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.

Secretary-Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Can.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill., and A. G. Pratt, The Babcock & Wilcox Company, New York.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

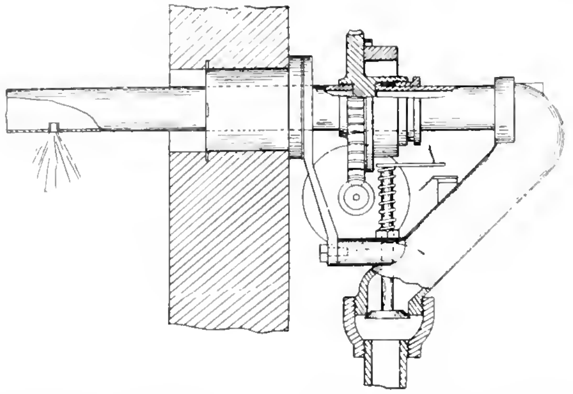
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,465,387. BOILER CLEANER. FRANK BOWERS, OF DETROIT, MICHIGAN, ASSIGNOR TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

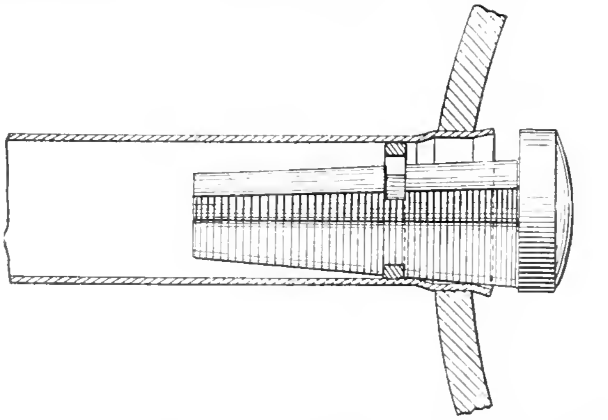
Claim 1.—In a boiler cleaner, the combination with a rotatable blower unit adapted to discharge steam jets or the like, a stationary supply pipe,



a valve therein independent of the blower unit, means to rotate the blower unit, and a rotary connected to said unit rotating means and arranged to operate said valve to automatically supply steam or the like from said supply pipe to said unit while the jets are directed toward predetermined portions of the boiler. Three claims.

1,465,118. MEANS FOR REGULATING WATER CIRCULATION IN WATER TUBE BOILERS. SAMUEL E. DIESCHER, OF PITTSBURGH, PENNSYLVANIA.

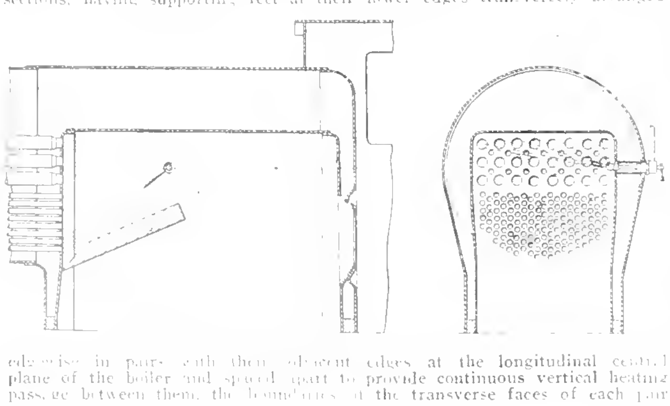
Claim 1.—A flow restricting plug for boiler tubes having three substantially equally spaced and radially extending tube engaging fins, each having



a slot therein and a snap ring located in said slots and adapted to engage the inner face of the tube when the plug is in place in a tube. Three claims.

1,463,250. LOCOMOTIVE BOILER. JOHN J. CAIN, OF BAYONNE, NEW JERSEY.

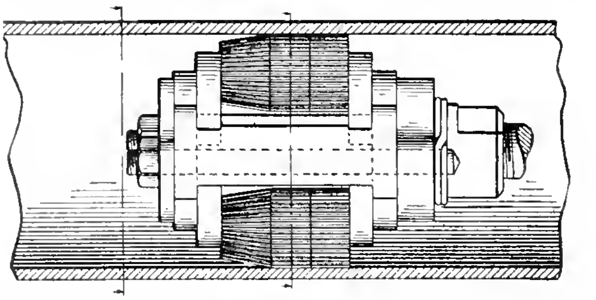
Claim 1.—A locomotive boiler, comprising similar narrow hollow vertical sections, having supporting feet at their lower edges transversely arranged



edgewise in pairs with their adjacent edges at the longitudinal central plane of the boiler and spaced apart to provide continuous vertical heating passage between them, the boundaries of the transverse faces of each pair being substantially equal to the vertical and transverse horizontal boundaries of the available space of the locomotive above its running gear, said duplex sections being in two sets longitudinally located in the boiler, the lower parts of the sides of the set of sections at the furnace end of the boiler being water legs and constituting the side walls of the fire box with their supporting feet at a lower level than those of the other set of sections, in combination with the main frame of the locomotive to the side girders of which the supporting feet of the sections are secured. Eleven claims.

1,463,587. BOILER-TUBE CLEANER. ALBERT F. KRAUSE, OF BUFFALO, NEW YORK, ASSIGNOR TO GENERAL SPECIALTY COMPANY OF BUFFALO, NEW YORK, A COPARTNERSHIP.

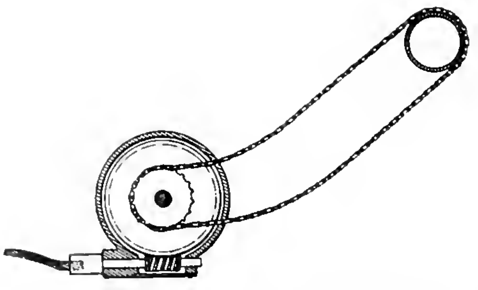
Claim 1.—A boiler tube cleaner, comprising a rotatable head, a cutter, a member carrying the cutter and movably mounted on said head, said



carrying member extending across and on opposite sides of the head, and controlling means for causing said carrying member to move in the direction of its length on the rebound of the cutter. Nine Claims.

1,462,415. APPARATUS FOR CLEANING THE OUTSIDE OF BOILER TUBES. FRITZ KOBER, OF SUHL, GERMANY.

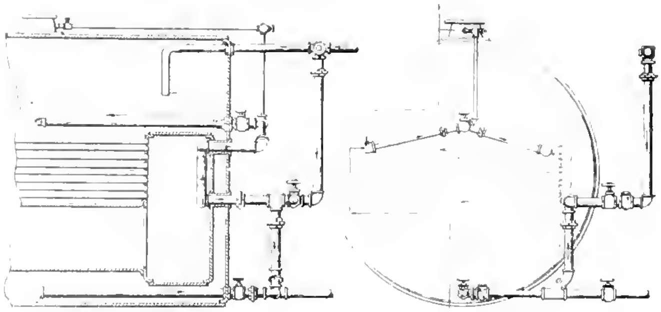
Claim 1.—An apparatus for cleaning the exterior of boiler tubes, comprising a portable operating mechanism, and an endless band or chain



having cleaning tools and operated by said mechanism, said band or chain being adapted to be passed around the tube to be cleaned. Two claims.

1,463,933. MARINE BOILER. RICHARD WALSH, OF MOBILE, ALABAMA.

Claim.—In a boiler, a heater coil, a pipe extended within the lower portion of the boiler and provided outside the boiler with a valve, a pipe connected with said pipe, a pipe rising from the last-named pipe, a lateral



branch therefrom connected with said coil, a pipe leading from the upper part of the coil, an upwardly-extended pipe leading from the last-named pipe and having a lateral branch with a valve, a pipe connected with said branch and extended within the upper part of the boiler below the water line, a steam pipe connected with the steam dome and with said branch and provided with a valve, a pipe extended upwardly and connected with the boiler and having means for connection with a feed pump, and a three-way valve controlling the flow from the feed pump, the flow to the boiler, and the flow through said pipe to the heater coil.

1,458,582. FURNACE AND BOILER CASING. CHARLES R. KLINE, OF READING, PENNSYLVANIA.

Claim 1.—In a device of the character stated, a casing for boilers, furnaces and the like composed of metal sheets lined on their interior with non-conducting material, a boiler in said casing having a door, a door opening in said outer casing sheet aligning with said boiler door, and a casing door closing said opening and hinged to said outer sheet, the inner surface of said casing door being provided with a lining of non-conducting material and the inner surface of said boiler door being also provided with a lining of non-conducting material, and an outer projecting member surrounding the opening into said boiler, said member being adapted to be embedded in the non-conducting material of said boiler door when the door is closed. Two claims.

THE BOILER MAKER

OCTOBER, 1923

The Dürr Boiler Works at Ratingen, Germany

By Captain Godfrey L. Carden*

Industrial conditions in Europe, especially in Germany, are not well understood in this country—and yet there are many phases of the situation that are of special interest to manufacturers and men in the shops. Captain Carden in the following article explains the status of boiler design and construction in one of the largest shops in Europe devoted to boiler work and outlines the tendency in design towards higher pressures and changes in types. The picture given of work at this plant reflects to a great extent conditions throughout Germany.

THE Durr boiler works at Ratingen, near Düsseldorf, is representative of the best in the boiler industry in the German Rhineland. Boilers of the Durr type were shown in the power installation of the St. Louis Exposition. Those particular boilers were of the marine type, and were part of a group for a German cruiser. The writer speaks advisedly on this point since he collected these and other foreign boilers as used at St. Louis.

I revisited the Durr Works today. The correct name of the plant now is "Düsseldorf-Ratingen Rohrenkesselfabrik Vormals Durr & Company." My talk was with director Loch, by whom every courtesy was extended.

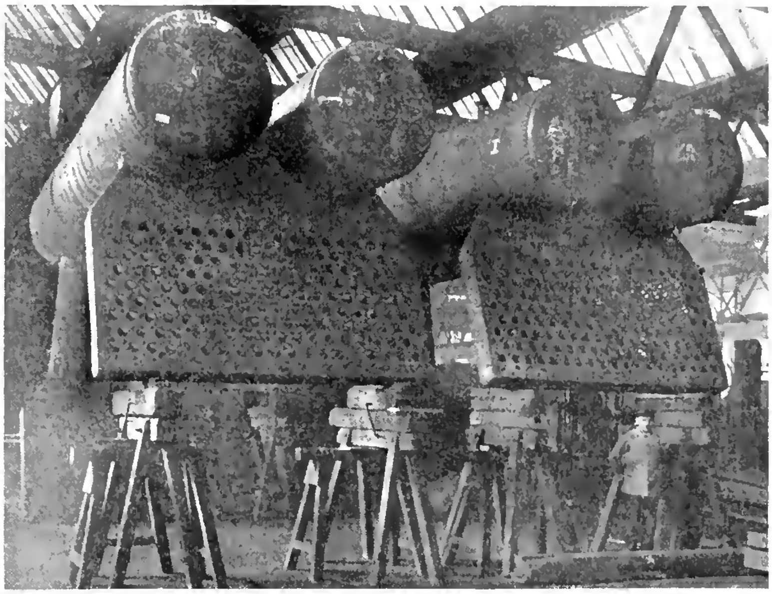


Fig. 1.—Completed Boilers at the Dürr Works

Large Staff of Men Employed

Here is a boiler making works employing as many as 1,000 men when working to capacity, and now carrying on the pay rolls 650. All work in the plant ceased September 12. No more raw material available and the impossibility of transporting products under the French occupation is responsible for the shut-down.

The Durr Works have orders ahead for nearly a year. These orders include both export and home fields. Nothing can be done to fill these orders until conditions change in the Ruhr and Rhineland. The same situation applies to all German works in the French occupied regions. No items may be sold and exported without a French license. The German government has forbidden its nationals to pay these licenses. The German manufacturer must choose between the French and his own government. He prefers the latter. The result in Ratingen has been that not a train whistle has been heard in that town in six months. The weeds and grass are growing on the railroad station platform, the rails are rusted, the station buildings abandoned; and it should be borne in mind that Ratingen is a unit in what is one of the most intensive iron and steel and machinery-producing centers in all Europe.

Foreign Orders Respected by French

Up to today the Durr Works continued to build equipment to meet orders in hand, the idea being to deliver such equipment whenever conditions warranted it. The French have respected foreign orders received before the occupation, but material produced subsequently has been subject to reparations demands. The result is that many German shops in the Ruhr and Rhineland which were building to stock do not know today if they can make delivery. They must first learn the French intentions as regards their goods.

The Durr Works has installed some of the largest power stations in Germany. Even with the shops shut down the engineering staff is hard at work on designs and improvements. Marine boiler work ceased with the close of the war and the Durr people are now paying attention almost wholly to the land installations. Boilers working at 34 atmospheres

*Captain Carden is an officer of the United States Coast Guard. He early saw service in Europe collecting boilers and engines for the power plant of the St. Louis Exposition. Later he served for two years for the Department of Commerce at Washington reporting on iron and steel and machinery and machine tool work on the continent of Europe. In that period he covered a wide range of territory, and gained first hand knowledge of conditions at several hundred of the first shops of the world.

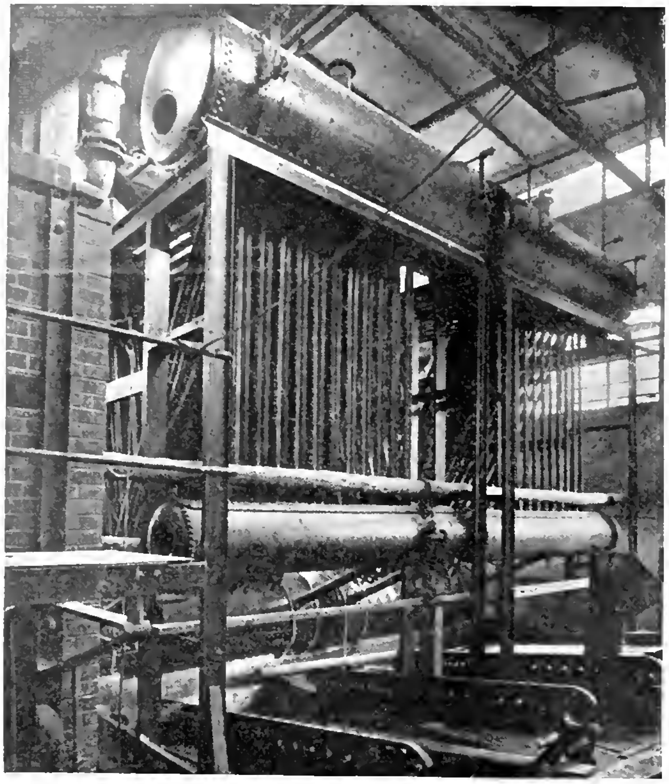


Fig. 2—Vertical Wet Tube Boiler Made at Esslingen

pressure (about 500 pounds) are the standard type, but boilers to work under 60 atmospheres (about 880 pounds) are also built.

Types of Boilers Being Built

The Durr boiler is generally built with two drums, above and below. Boilers with only one lower drum are used for small units and small capacities and chiefly for utilizing the waste heat from Siemens-Martin and annealing furnaces and coke ovens. The newest Durr boiler is distinguished by its use of Garbe plates and vertical tube nests with straight tubes. The standard capacity of these boilers is rated at 25 to 35 kilos (about 55 to 72 pounds) each hour per square meter (10.76 square feet) of heating surface. Under forced service this capacity may vary from 35 (about 72 pounds) to as high as 50 (about 110 pounds) kilos.

The boiler sizes range from 30 up to 2,000 (about 323 up to 21,450 square feet) square meters total heating surface. Until comparatively recently very few boilers were made in Germany for land service having more than 1,000 (10,764 square feet) square meters' heating surface.

Limits in Size of Boilers

The rule has been to keep the sizes under 600 square meters, and, therefore, we find the 600 (about 6,460 square feet) square meter-boiler the size most commonly in use. The current opinion held among German engineers, that the big boiler with a heating surface of over 2,000 (about 21,450 square feet) square meters, such as seen in America, was not suited to German conditions where the power requirements and available fuel are somewhat different.

In my talk with director Loch I learned that boiler work in Germany had been very much advanced in the past year through a more general recourse to vertical tube boilers. When vertical tube boilers were first offered on the market in past years there was no success. This was due in part to the serious opposition of competing systems. The principal defect with the first vertical tube boiler was the fire vault over the grate. There was always danger of falling in after service under long working periods. The first steep-tube boiler yielded wet steam, resulting in frequent disturbances in the steam turbines. In the case of the fire vault the design has since been changed so that now the length corresponds more to the American ideas. According to director Loch the Sterling and Garbe boilers have taken the lead in Germany in the past year. The original Garbe has been taken over by the Durr Works and improved upon. The Garbe boilers are entirely without welded or pressed headers, staybolts or pipe closes. The Garbe plates are pressed, corrugated and step shaped. No tightening of the tubes is necessary, the tubes are arranged in straight rows. There is easy accessibility to the back rows. Under the vertical arrangement there is no chance for mud to be deposited in the tubes. The mud collects at the lowest point in the lower drum from where it can be blown off.

The Durr Works have made installations for some of the largest power units in Germany. These include the power plant at Golpa, which plant is at present supplying the electric current of Berlin, the Goldenberg Works of the Rheinisch-Westphalien Electrikal A. G. located in the Rhine brown coal district and the Amoniac Works at Merseburg. All of these installations have the steep-tube boiler and are fired with low grade brown coal.

Adaptability of Steep-Tube Boiler

It has been found that the steep-tube boiler is well adapted for service under lignite firing with the attending dust which characterizes that fuel. The ashes do not accumulate on the steep inclined water tubes, and the heating surface is unimpaired. Similarly, there has been a turning in the recent past, says director Loch, to the riveted water chamber, because of boiler explosions occasioned by the tearing off of the welding line of chambers.

The marked tendency today, it was declared, is towards higher boiler pressures. The "Atmos" 100 (about 1,470 pounds) atmosphere pressure boiler is being built in Germany, in Madgeburg at the Sudenburger Maschinenfabrik und Eisengiesserei. This is a Swedish design, the parent house being located in Stockholm. In the Atmos, revolving tubes are used, turned by electric drive. In case the motor drive should stop, the danger from explosion is taken care of through providing the tubes with fusible plugs which fuse when the temperature of the tubes rises to about 400 (about 752 degrees F.) degrees Centigrade. The steam thereby escapes into the furnace, serves to cool the brick work, and thus prevents any bending of the tubes. Under the same arrangement, the safety device functions if a tube should be empty of water by incrustations in the inlet tube.

High Pressures Adopted

Among the German boiler makers a conference was held in June, 1921, at Cassel, at which time director Hartmann of the Schmidt Hobsteam Company spoke of the great economy obtained from high steam pressures of say 60 (about 850 pounds) kilograms working pressure. Up to this time no plants in Germany were using such pressures. What is now common is the 30 to 35 (435 to 506 pounds) kilograms pressure boiler. Under the present tendency the pressures are to be advanced to 60 (about 850 pounds) kilograms and for such pressures the lower and upper drums of the Durr and similar type boilers will be forged from one piece, after the Krupp process and using Krupp steel. It is believed that the 60 kilograms (850 pounds) pressure boiler is more in keeping with conservative ideas than the 100 kilograms (1,447 pounds) boiler. The latter type as made by the Magdeburg firm has, I understood, tubes of 305 millimeters (about 1.20 inches) outside diameter, 10.5 millimeters (about 0.413 inch) wall thickness and 2,500 millimeters (about 5.28 feet) of gas contact length. The tubes revolve with a speed of 330 revolutions per minute. By means of centrifugal

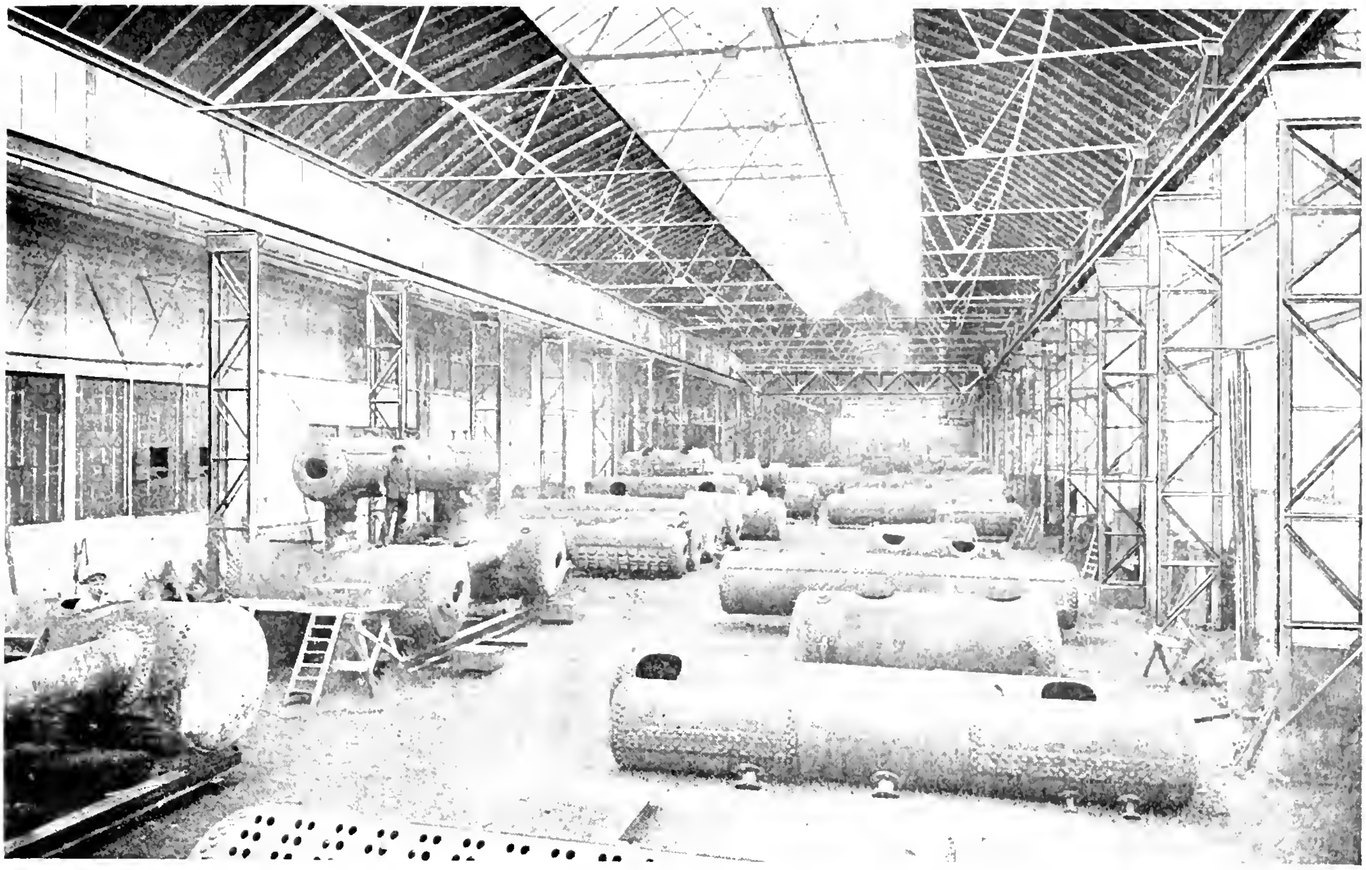


Fig. 3.—Assembling Boilers at the Dürr Shops. Garbe Plate in Foreground

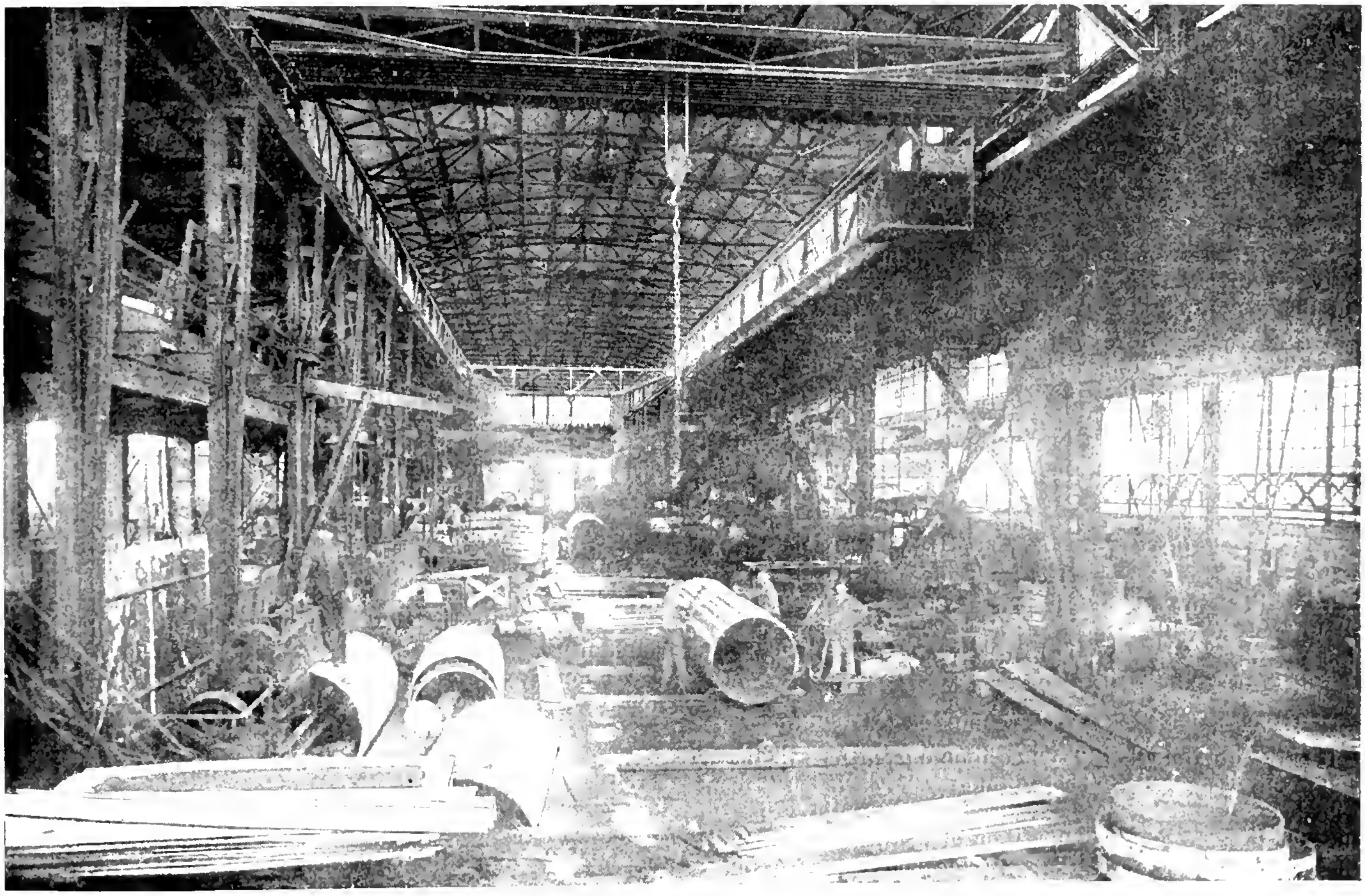


Fig. 4.—Assembling Bay for Garbe Plate, at Ratingen Works

power a water jacket is pressed to the internal heating surface. The tubes are revolved by tooth gearing, electrically driven.

Difficult to Obtain Fuel

Just now because of the Ruhr occupation and the shutting off of fuel from the unoccupied territory, coal of good quality is very difficult to obtain in Germany. Recourse has been had to England and Moravia, but in the main Germany has turned her attention to the brown lignite fields. This is a low grade fuel and those power stations which heretofore used first-rate coal must now be satisfied with low grade fuel. For the firing of this brown lignite coal it is found that the normal, not the mechanical, step grate is the more advantageous. As director Loch put it, the general view held in Germany today is to work designs best adapted to our low grade fuel, and which designs will offer the maximum of freedom from boiler explosion.

Scale Formation and Its Prevention

British Experience in Using Boiler Compounds and in Eliminating Boiler Difficulties Caused by Hard Water

By T. Sington

An eminent English expert has recently expressed the opinion that there is no "short cut" in water softening to prevent boiler scale. A steam user burdened with hard water has only one course open to him, should he really desire to avoid coal waste and boiler damage, that is, to soften the water in accordance with well-known reactions in a properly designed apparatus, before it is fed to the boilers. Should he do so he would get the maximum result at a minimum cost; but should he pin his faith to boiler remedies, he would obtain the minimum result at the maximum cost and, in addition, incur the risk of damaging his boilers into the bargain.

The following analyses of some boiler compounds widely sold in England illustrate the worthlessness of these and indicate the profit, by no means on a modest scale, at which they are sold to the consumers:

(A) Sold at $0.72 per gallon: Water, 97.50 percent; sodium carbonate, 2.50 percent; tannin extract, 0.20 percent; sugar and others, 1.42 percent.

(B) Sold at $0.48 per gallon: Water, 97.50 percent; caustic soda, 0.70 percent; algin and others, 1.80 percent.

(C) Sold at $2.40 per gallon: Water, 5.01 percent; chalk, 57 percent; mica, 31 percent; sodium carbonate, 6.99 percent.

None of these compounds, even if used in large quantities daily, could conceivably have any noticeable effect in retarding the deposition of scale by many waters now in use. Nevertheless, comparatively small concerns spend as much as $1,000 per annum on one of them. Such firms could soften the whole of their boiler feed water to three degrees by the expenditure of only $120 yearly, if they would employ lime and soda in a proper apparatus. Inspection of the boilers of these concerns showed that they were badly scaled, despite assurances that the fluid was used regularly and had given satisfactory results.

As many people who are in close touch with feed water problems are aware, the clearer comprehension by steam users of the simple chemical facts, which form the basis of all water softening methods has led of late years to a considerable decline in the sale of what may be called *"quack"* remedies for boiler scale.

Guarantees Rarely Offered for Compounds

It is rare to find a boiler composition offered for sale under a guaranteed analysis. There is no mystery whatever about orthodox water treatment. If steam users would insist on knowing the percentage composition of the boiler compounds offered to them as remedies for scale and corrosion, there would be a rapid disappearance of these compounds from the market, as very few of them would survive the publication of their ingredients.

The direct treatment of the feed water in the boiler itself is only a matter for boiler plants of a very restricted size. In a boiler plant of any reasonable capacity the only thing to do, of course, is to install a softening plant, at any rate for water over 7 to 10 degrees in hardness and to take out the scale-forming elements before the water goes into the boilers. With a small installation, it may not pay to go to the expense of a softening plant. To quote an expert—"the desirability of pure water for boiler feed purposes is well known to every steam user and for the most efficient results it is necessary to have water certainly not over 5 degrees total hardness, together with freedom from substances such as air, carbonic acid, oil, salt, natural acids, and of course added mineral acids, such as sulphuric acid from pyrites in coal measures, which may cause corrosion. Hardly any natural water is absolutely pure and very few would comply with the above specification, so that for the advantage of the boiler plant, it is essential to treat the feed water. The trouble is, however, that with small or even medium sized boiler installations the initial expense of a softening plant and particularly the trouble of looking after it, together with the cost of lime, soda and of other material necessary is apt to be a somewhat formidable item.

Natural waters are rarely pure, the average hardness may be say 12 grains per gallon, that is, for every gallon evaporated, 12 grains of solid material are deposited in the boiler plant. Of course, individual waters vary greatly; they may contain anything from say 2 to 50 grains, but 8 to 16 grains is a reasonable average.

Annual Fall Meeting of American Welding Society

The annual fall meeting of the American Welding Society will be held in Pittsburgh from October 24th to 26th, 1923. A tentative program of the meeting follows this announcement.

A unique feature of this meeting will be the opening session on Wednesday morning. President Barton will present a general statement of the Society's affairs and an opportunity will be provided to all the members to discuss the activities and policies of the Society. While a good part of the work must necessarily be done by a limited number of committee members, nevertheless, the advice and assistance of the entire membership is needed and wanted at all times.

(Continued on page 290)

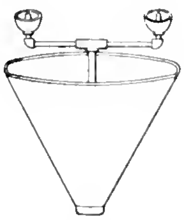


Fig. 10-Double Drinking "Bubble"

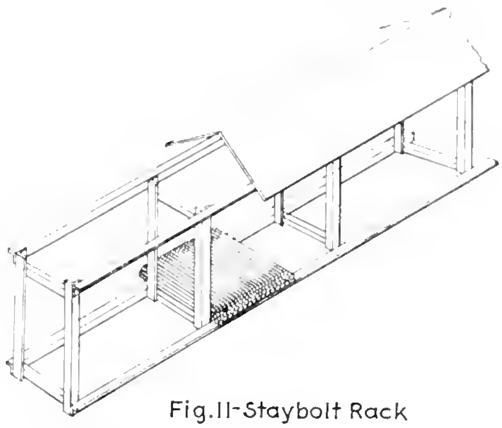


Fig. 11-Staybolt Rack

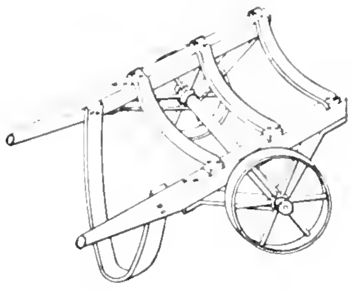


Fig. 12-Tube Handling Truck

Time Saving Devices for Boiler Shops*

Appliances and Methods That Various Shops Have Found Useful in Repair Work

By James F. Hobart

ON a trip to the Memphis shops of the I. C. Railroad the writer was shown the sections of apparatus for a double bubble drinking-fountain, a tube-handling truck and a stay-bolt rack illustrated in Figs. 10, 11 and 12. The drinking-fountain consists of two regular "bubble" drinking nozzles with porcelain covered guard cups which were open at the bottom and discharged into the galvanized metal oval funnel shown in the picture. The bubbles were connected by pipes and a tee to the same vertical pipe, and were located about 20 inches apart, giving room for two men to drink at the same time. The saving in time thereby can be appreciated, as it seems a fact, that whenever a man stops to take a drink of water, another man will come along and wait for the first man to get through. The double-bubble prevents much time being lost in waiting, for, although each wait is of but a few minutes' duration, it surely counts up in the aggregate during the day.

These bubbles are allowed to flow all the time, there being no valves for closing them off, save a main valve which is closed at night only. If iced or carbonated water were to be served, the bubbles could not be permitted to flow all the time, but in the I. C. shops, plain water was used for drinking purposes.

Storing Staybolts

Staybolts by the thousands are stored in the Memphis I. C. shop in such a manner than any size or lot, is instantly accessible. Little steel, open-side houses, 10 inches in width by 18 inches high from sills to plates, are provided in 5-foot sections as shown by Fig. 11. The frame is made of 1¼-inch steel angles, the roof, of 10-gage steel.

A great many staybolts are made in these shops, and double staybolt threading machines, electrically driven, are provided for manufacturing staybolts in great quantities.

Some Interesting General Notes

The working floors of the boiler sheds are filled in with cinder to a depth of several inches, making a floor much softer than concrete. Each punch and shear is electrically driven by a motor which looks ridiculously small when compared with the size of the driven machines; but carrying power is obtained from a five-foot balance wheel, with a rim about 6 by 6 inches working upon the pinion shaft of each machine.

The punching and shearing machines in this shop are operated by colored workmen. Each machine is independently electrically driven and the bending rolls are reversed by means of overhead connections with the motor. A band, metal saw is something of a novelty in boiler shops but it is in use in this one.

Handling Boiler Tubes

Boiler tubes up to five inches in diameter are cut off by a single wheel machine similar to an ordinary pipe cutter except that the cutter is stationary and the tube is revolved by power. Supporting the tube during the cutting-off process, are two small flat wheels or rollers, placed a short distance apart, but nearly opposite the cutting wheel.

Tubes are cleaned in a rumbler, which is located in a tight house—power and all—weighted vertical doors being provided for putting tubes in and out. The scale and dirt is removed through a cleaning door at bottom of the house. This arrangement keeps nearly all the dirt in the house, together with nearly all the noise.

Tubes are handled from boiler to shop and back again by means of little hand trucks, or two-wheeled barrows, made up as shown by Fig. 12. This vehicle, save for the wooden side-rails or handles, is built entirely of metal and surely is a rugged bit of construction. The cross bars are concaved as shown, to receive a batch of tubes and to keep them from rolling off the vehicle. The truck, or barrow, is held in nearly a level position by a loop or stirrup of bar steel, bent as shown, to reach to the ground. The workmen, in using this vehicle, never need but one lesson in regard to loading the tubes so as to "hang" properly. If loaded too far forward, the front of the truck cannot be raised from the ground. If loaded too heavy behind, the barrow lifts itself, and "sits down" with alacrity if not with elegance. But

*Continuation of an article, "Home Made Appliances for Boiler Shops," which appeared on page 222 of the August issue of THE BOILER MAKER.

properly loaded, two men handle a load of tubes with considerable ease.

Pipe Fitting and Bending

In an ice-plant repair shop at Vicksburg, Miss., they have a way of bending pipe whereby the pipe is first filled with water, a cap having been placed on one end of the pipe. Then, a "hydraulic fitting" is screwed upon the other end of the pipe and after having been carefully and completely filled with water to the exclusion of every particle of air possible, a plug is screwed into the hydraulic fitting, with result that considerable pressure is placed upon the water in the tube and the engineer of the plant told the writer that the pipe would "bend like lead," without flattening in the least. "And," the engineer continued—"you have tested the pipe too!"

In the I. C. shops at McComb, Miss., and in the T. & P. shops at New Orleans, they seem to be "long" on air cylinders, which look very much like the old-time steam brake cylinders which used to do such good work on locomotives before air brakes came into use. A lot of these cylinders, operated with air, have been put to use in both the shops mentioned above, in the operation of "home-grown" tools.

A pipe-fitting and bending table or bench in the I. C. shop has two such cylinders for operating pipe vises. This pipe-bench, which is a "dandy" is represented at *A* in Fig. 13. The top of the table is a massive metal plate which is supported on stout timbering as shown at *B*, into which are framed several stout legs *C*, *C*, and one very much stouter at *D*, to which is attached an enormous vise *E*, by means of heavy metal straps and bands *F* and *G*, in a manner so strong and rigid that it is almost impossible to pull the vise away from its fastenings, particularly as the bench-posts are let into the concrete floor of the room.

A pipe-bending plate is attached as shown at *H*, being made fast to the top of the bench. A large number of holes, *I*, *I*, have been drilled through plate *H*, and pin *K*, and sheave *J* can be juggled around from one hole to another until they are in proper position for bending any curve required in pipe for fitting up boiler connections.

There are two pipe vises with this bench, and they are both unique as well as home-made. The smaller vise, located at *L*, is bolted fast to the bench-top and this vise has a movable jaw which is attached to lever *M*, which in turn is connected to, and operated by air cylinder *O*, which seems to be one of the before mentioned, discarded steam-brake cylinders.

Whenever a piece of pipe is thrust between the jaws of vise *L*, and air turned into cylinder *O*, it is a pretty safe bet that the piece of pipe will stay between the jaws without turning, as housing *N*, is bolted to the bench too strongly ever to be torn away by air-power in cylinder *O*, or man-power on a pipe in vise *L*.

Another pipe vise at *P*, is a much larger and stronger one. Its lever *Q*, and housing *R*, are strong and massive. Cylinder *S* develops power enough, with the leverage of *Q*, to hold fast pipe of any size which can be put between the pipe-vise jaws.

Air-Operated Shear

Several machines almost similar in their method of operation, to the pipe-vises, are to be found in the T. & P. shops (Texas & Pacific) at New Orleans, and the same utilization of obsolete steam brake cylinders is apparent. In Fig. 14, it is shown how shear-lever *A* is mounted in housing *B* and carries shear-jaw *C* which members with a similar jaw *D* which in turn is bolted fast to casting *E* and both members made fast to base-timber *F*.

The shear is operated by air-cylinder *G*, to which lever *A* is attached by means of the link arrangement at *H*. Treadle *I* operates air admission and exhaust to and from cylinder *G*, and thus controls the action of this rugged home-made shear.

Post, Air Bending Clamp

A very handy and frequently used appliance for bending narrow rod or bar steel, also some pipe, in the T. & P. shops, is shown by Fig. 15. The engraving shows the appliance so clearly that little description is necessary save to say that a sort of anvil-mold *A*, of shape required for the work in hand, is placed upon block *B*, the form being notched in this instance, to fit over the block. The metal to be bent, being heated and placed upon *A*, head *C* is forced down by air-pressure in the cylinder and the object is held securely upon form *A* while being sledged down to fit thereupon, or to the angle desired. A variety of shaped forms may be used upon block *B*, which is made of such height that plunger *C* can always reach the work without exceeding in length-movement, the length of the air cylinder.

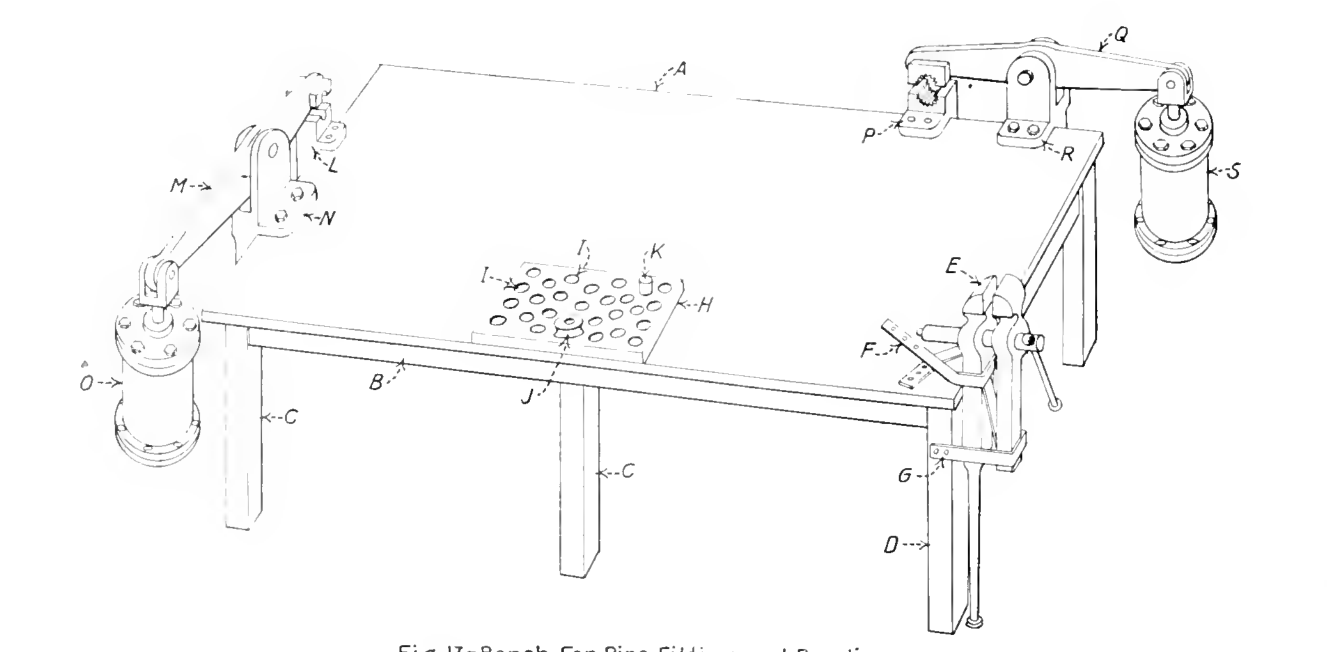


Fig. 13—Bench For Pipe Fitting and Bending

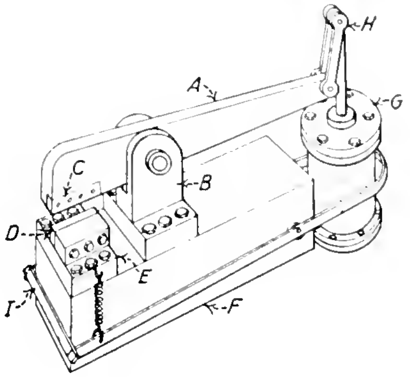


Fig. 14—Air Operated Shear

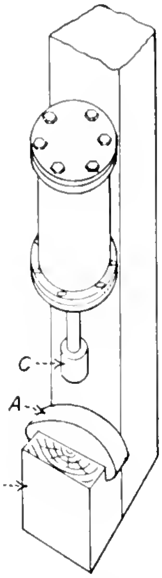


Fig. 15—Post Air Clamp

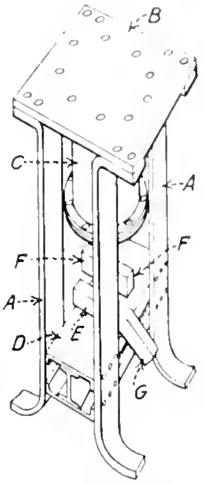


Fig. 16—Air Clamp Bender

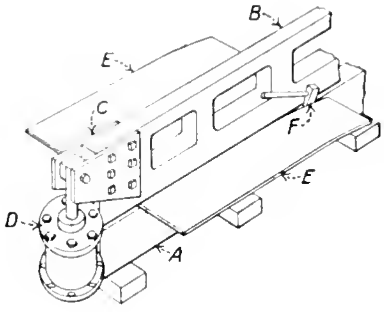


Fig. 17—Hand Cutting In An Air Clamp

A machine which is portable in the sense that it may be carried to the work by the shop crane is shown by Fig. 16 herewith. This machine is made much upon the principle of the one last described, save that instead of being attached to a post, stress is borne by the four leg-posts, *A-A*, which in turn are bolted to top plate *B*, which also carries air-cylinder *C*.

The anvil of the appliance, *D*, is built up of channels and an I-beam. To this anvil may be attached any former or die, as *E*, upon which members another die or former *F-F*, which is attached directly to piston rod of the air cylinder *C*. In this instance, former *E* is shown elongated and bent down at an angle at *G*. After the stock to be bent has been smashed into shape between formers *E* and *F*, it may be further sledged down against extension *G*, as may be required.

A couple more old steam-brake cylinders have been put to use in the T. & P. shops by being attached to a big, husky bending clamp. Only one of the cylinders is shown at *D*, in Fig. 17, the other cylinder not being shown in the engraving, in which *A* represents the lower member or jaw of the press, and *B*, the upper or movable one. A pair of extension plates *C*, attached to *B*, forms connection with the air-cylinder *D*.

At the time the writer saw this modified tool, a couple of workmen were doing a job of hand sheet-cutting with it. Plate *E-E* had been put in position to be cut along the side of jaw *B*. One man took a cold-cutter and held it as shown at *F*, the other man striking the cutter with a sledge. The lower clamp-jaw *A*, formed with cutter *F*, a shear which severed plate *E* very smoothly.

Welded Joints in Unfired Pressure-Vessels*

THE tests which have recently been conducted at the Bureau of Standards have in our opinion justified in a great measure the claim made by the welding fraternity. These tests have also justified and confirmed the conclusions already drawn by *The Travelers* from a review of the experience with welded, unfired pressure-vessels now in service—this experience representing over 10,000,000 tank-years. *The Travelers* is, of necessity, conservative, and we have been slow and reluctant to join in any movement urging the inclusion in the A. S. M. E. Pressure Valve Code of requirements which would permit fusion welding. We have felt the need for just such facts as are now available through the series of tests conducted at Washington; but for our own purposes—that is, for insurance purposes—we have felt that such additional proof was not a necessity. We are governed by federal, state and municipal laws wherever they apply effectively; but in many cases these laws do not apply to unfired pressure-vessels, whereas insurance is universally applicable.

We are now insuring, and have insured in 1922, pressure-vessels of many kinds and at varying pressures—vessels having their longitudinal (as well as their girth and head seams) fusion-welded. We are satisfied now, and we were satisfied before these recent tests were made, that fusion welding can be made insurable. Our experience with it has been satisfactory, and we expect to continue to insure welded vessels with equally good results.

Fusion welding is an art which has certainly come to stay, and we believe that we can best serve the interests of the public, and assist to a greater degree in the safe development of welding practice, by working with the welders, with the manufacturers, and with the various engineering societies authorized to establish rules and regulations, as far as we can consistently do so.

When fixing, for insurance purposes, the safe working pressures of fusion-welded unfired pressure-vessels, we have been arbitrarily assuming (pending more definite methods of determining the ratio of the value of the weld to the value of the solid plate) a joint efficiency of 50 percent. We further reserve the right, as does any insurance company, to accept or reject any or all tanks, either before or after inspection. The point I wish to bring out is, that we do not consider a tank uninsurable, merely because it is fusion-welded.

As a result of the data now available, and submitted by the Bureau of Standards, there is no reason why a good

(*Continued on page 285*)

*Remarks by H. W. Heinrich, Engineer, of *The Travelers*, at the Welding Conference, New York City.

Measuring Production Costs in Industry

The Key to Correct Costs—The Necessity of Using Accurate Cost Methods

By William R. Basset*

IT takes but little skill to determine exactly what the labor and material in a product cost, for these can be accurately measured with but little effort. Overhead expense is not so easily measured. It is inaccurate allocation of overhead that causes most inaccurate costs.

The pity is that the man who has an elaborate cost system may be getting wrong information from it, while believing that his cost figures are trustworthy. He who has no figures is better off than he who has wrong ones, for at least the first man knows that he is merely guessing.

General Rules for Keeping Costs

No one method of getting overhead into the product will do for all industries nor for all concerns in an industry, but the same methods of gathering the costs fit all. Here are the fundamentals of correct accounting for overhead.

1. Gather overhead, not for the plant as a whole, but for each department separately.

2. Charge the overhead of a department only to those items of production that are operated upon in that department.

3. Overhead is a charge that the product must pay to a department for the use of the facilities furnished by that department. These facilities may include floor space, heat, light, power, supervision, non-productive labor such as truckers and janitors and perhaps a rental for the use of machines. Therefore, it is important to determine a way to measure in dollars the use that the product has made of these facilities. It may be measured differently in every department. In one the man hour may be correct, in another the machine hour, the payroll dollar and so on. To determine the unit is a job for someone fully acquainted with the problems in the plant.

In plants where overhead is incorrectly spread over the product I have seen cases where costs were 50 percent and more off. Some were too high and others too low by that much. Such a condition makes business too much of a gamble.

Setting the Selling Price

Of three uses to which cost figures can be put, most concerns use only one—and that one the most obvious. They use it as a basis for setting a selling price in normal times.

When business falls off in a depression they commonly either throw the whole system overboard in the effort to cut expenses, or they utterly ignore the figures.

Now anyone knows that it is better in an emergency to sell at a price which although below cost, will keep the plant going and bring back part of the unavoidable overhead, rather than to shut down and lose all of the overhead. But without figures which show all of the items of cost accurately, there is the danger that a price may be set so low that the losses will be greater than if the plant were shut down. Nothing is gained unless the cut price brings back the cost of labor and material and a certain part of the overhead expense.

Properly developed costs show just where that point is.

The other seldom used feature of a cost system is its ability to show where costs of operation can be cut—where, in other words, the efficiency of the plant can be increased. The cost system is the most effective indicator of where betterments can be made.

In one plant a new cost system showed that the usage of dyeing and bleaching materials fluctuated widely from month to month. This led to a study of the methods, which showed that the solutions were not based upon scientific formulas but upon the guess work of a none too skillful foreman. Standards were set for all solutions with the result that the usage of dyeing and bleaching materials was cut about $18,000 a year.

In a machine shop a sudden rise in the use of lubricating oil for automatic machines was shown by the cost system. It came out that an inferior quality of light oil was being bought by the purchasing agent. This oil, under pressure, went through the machines so fast, that not only was the monthly cost for oil higher, but the lubrication was insufficient and had the practice not been stopped, a hundred thousands dollars' worth of machines would have been badly damaged.

The wise executive carefully studies his cost figures to spot inefficiencies such as these.

How Big Should the Plant Be?

Closely allied with the problems of overhead and cost systems is the question of the best size for a business.

Almost every man feels that if his business were only larger, his profits would be greater and all would be well. A business man's career is usually a continuous struggle to make greater sales and to make his plant larger.

Undoubtedly the manufacturing of the future will be done by the large enterprises for only they can achieve the economies of mass production. But it does not follow that it will be done in tremendous plants, centralized in one location. Far-sighted business men and engineers realize that the big plant is not always the most economical one either for making or for selling.

There is a best size of manufacturing unit for each industry. The big business will have many such units spread over the country.

If a plant is too small it cannot afford to pay the price demanded by men capable of manufacturing economically for it cannot utilize all of their ability. It must put up with inferior, cheaper talent.

If on the other hand the plant is too large, executive supervision will not be able to cover it completely. There will be a fringe that will escape proper supervision. That means that something or other will constantly be going wrong.

To determine just how large your plant should be, for best results, is a study that will well repay the effort and time taken.

Maintaining Oxy-Acetylene Equipment

THERE is probably no class of equipment used in mechanical plants which receives so little proper care as welding and cutting apparatus. It is so easy to maintain such equipment in good operating condition and the results of such maintenance represent so great a saving in gases and efficiency that the little care necessary pays for itself many times over. There is nothing more exasperating to an operator than a torch or a regulator which is in bad condition. He cannot properly maintain a neutral flame and his torch may be constantly flashing back, all caused possibly by a little dirt in the torch or a leaky regulator.

* President, Miller, Franklin, Basset and Company, Inc., New York City.

Making Charcoal Iron for Boiler Work

Development of the Manufacturing Process with an Outline of the Qualities of Charcoal Iron

By G. A. Woodroffe*

CHARCOAL iron tubes have for generations proven their qualities in heavy boiler service. Probably most of our readers use these tubes, but few understand the manner in which the iron is made—as indicated by the many requests for information on the subject. The following details of charcoal iron production methods as carried out by a well known manufacturer of the material will clear up some of the questions that have occurred to those using boiler tubes made from charcoal iron.

Uses for Charcoal Iron

Charcoal iron, made by pain-staking hand-working in small forge fires of very limited output, is the purest of commercial wrought irons. Because pure iron is highly resistant to corrosion, charcoal iron has long been used in the manufacture of boiler tubes for locomotive, marine and stationary service.

In some quarters there is an impression that real charcoal iron is no longer obtainable. Metallurgical science and mechanical ingenuity, during the last half century, have evolved newer and cheaper methods of making certain kinds of iron and steel when tonnage output is of maximum importance, but there is yet to be developed another and better method of making charcoal iron, or an iron of equal purity.

While full advantage is taken of advanced laboratory knowledge making possible better metallurgical control, charcoal iron is made today exactly as it was 50 years ago. The little hearth fires have not changed, some of those at the plant from which this data was taken having been in continuous use nearly 50 years. Charcoal is still the fuel because it is practically free from sulphur. (Iron absorbs impurities and if coal or coke, though lower in price, were used as fuel, the iron would be unfit for boiler tube use.) Men, trained at the forge, work the glowing charge with long knobbling irons, just as their predecessors did.

Methods of Producing

Briefly, real charcoal iron can be produced from a charge of ore, pig iron, run-out metal, pieces of wrought iron, or pieces of steel, refined in a small forge fire of charcoal and worked by hand until the impurities are removed and the charge undergoes a complete change, becoming an almost perfectly pure, plastic iron.

For a better understanding of the charcoal iron making process, let us remember that charcoal iron is 99.86 percent pure, and that its manufacture is essentially a process of refining iron ore or any one of several ferrous metals to pure iron. Ore, which is high in certain impurities, can be reduced to charcoal iron, but the refinement involves slow working and the use of considerable charcoal. White pig iron or run-out metal lower in impurities, can also be used as the charge and made into charcoal iron with less working. Or, the operation may start, further along the scale, with certain kinds of steel, from which most of the impurities have already been removed, so that the time required for the desired refining is still further reduced. In any event the finished product is the same, pure charcoal iron.

Impurities in Iron Reduced

The objectionable elements of carbon, manganese, sulphur, phosphorus and silicon, present in every form of iron and steel, are reduced to the merest trace in charcoal iron, their combined content being less than fourteen-one-hundredths of of 1 percent, as will be observed from the following analysis of a specimen of charcoal iron:

	Percent
Carbon	0.03
Manganese	0.03
Sulphur	0.015
Phosphorus	0.03
Silicon	0.03

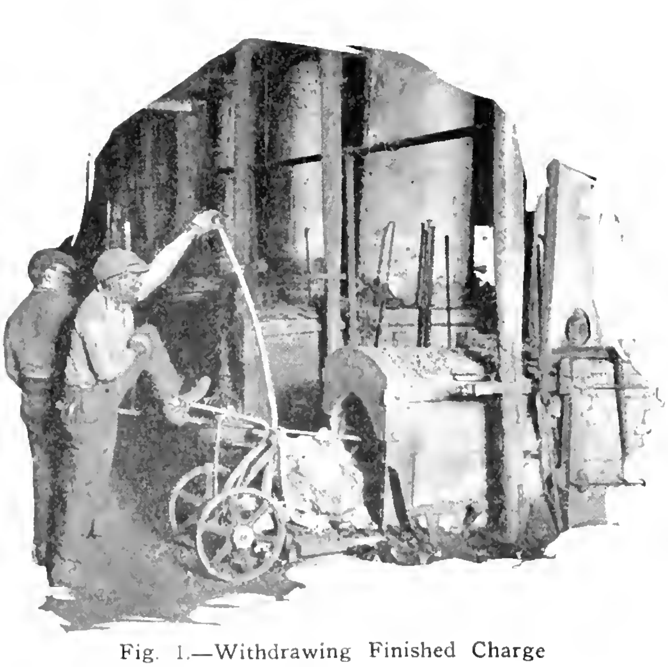


Fig. 1.—Withdrawing Finished Charge

*Metallurgical engineer, Parkesburg Iron Company, Parkesburg, Pa.

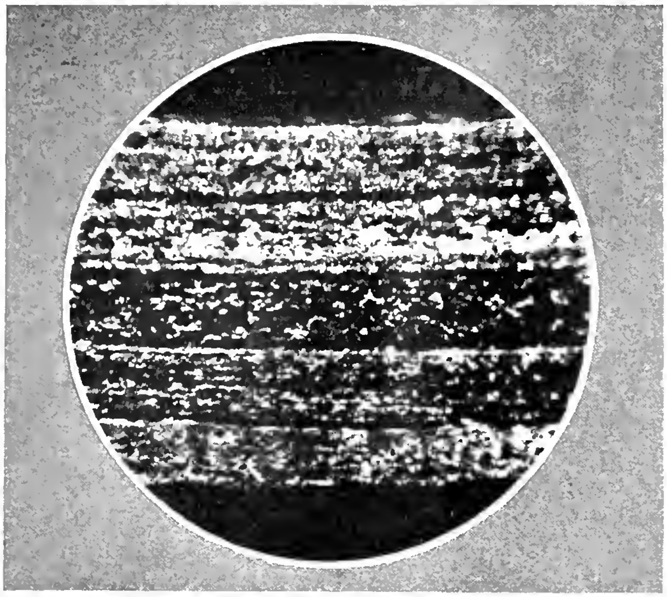


Fig. 2.—Microphotograph of Charcoal Iron Showing Layer Formation

The charcoal iron of primitive man was extracted from ores, refined probably in crude stone fireplaces on hillsides, the air to support combustion being supplied by natural draft through passages dug through the hill and facing the prevailing winds. The refinement of the ores containing many impurities was unquestionably a slow and inefficient process on account of the uncertainty of the blast and the lack of skill and knowledge of the artisans. Much charcoal and many hours were required to produce a lump of crude iron weighing less than 50 pounds.

Blast Furnace Utilized

With the development of the blast furnace, the charcoal iron maker began to employ pig iron instead of the natural ore as his basic charge. There was no change, however, in the resulting product, which was charcoal iron. While some of the impurities had already been removed from the pig iron in the blast furnace, the average carbon content of the pig was about 3.50 percent, and required much charcoal and considerable time properly to effect the desired refinement.

While much of the impurities had been removed in the blast furnace, there were still present in the pig, considerable quantities of carbon, manganese, phosphorus and silicon which required much charcoal and considerable time to reduce.

Knobbling Time Reduced

A further reduction in the knobbling time was secured by remelting the pig iron and running it out into flat, chilled plates, called run-out metal, which were then charged in the charcoal fire. The remelting having removed some of the impurities, less time was required for conversion, and the final product was real charcoal iron. Next, the advent of the puddling process of iron making released quantities of wrought iron scrap mixed with steel scrap which replaced the run-out metal as the charge.

About 1870, the development of the steel industry provided ideal material for charcoal iron manufacture. Certain kinds of light weight steel, low in carbon and other impurities, could be cut into pieces which were not only purer than the run-out metal or wrought scrap, but were much easier to handle.

Since the early '70's steel has formed the charge from which charcoal iron has been made. The resulting product, its composition verified by chemical analysis, and its corrosive-resisting qualities demonstrated by actual service, differs not at all from charcoal iron made from ore, pig iron, run-out metal, wrought iron scrap.

When removed from the hearth-fire for further working under a steam hammer, the incandescent, slag-exuding lump is no longer steel, but an almost entirely pure plastic iron. The original charge has been changed from steel to iron, just as in the open hearth process a charge of scrap metal and pig iron undergoes physical and chemical changes which make it steel instead of iron.

Summation of Process

Summing up, briefly: The charcoal iron maker, starting with a small, 300-pound charge of the very best material the steel maker can supply, works it by hand in a fire of pure charcoal until impurities left by the steel maker are reduced to the merest trace and the charge undergoes a complete change in structure and composition, becoming pure charcoal iron.

Fig. 3.—Sixteen Thousand Bushels Like These are Used at the Plant Each Week in Making Charcoal Iron Boiler Tubes

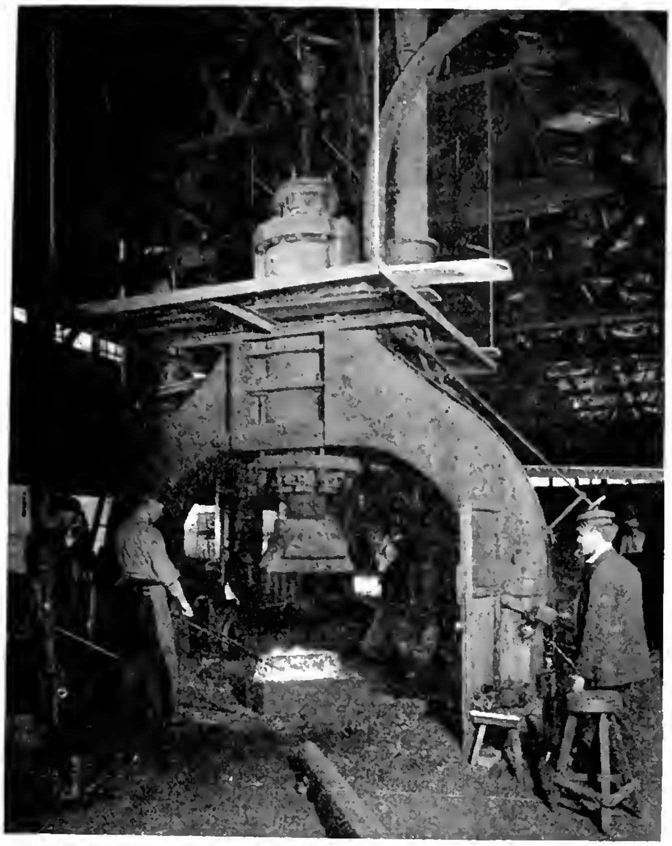


Fig. 4.—Shingling the Bloom

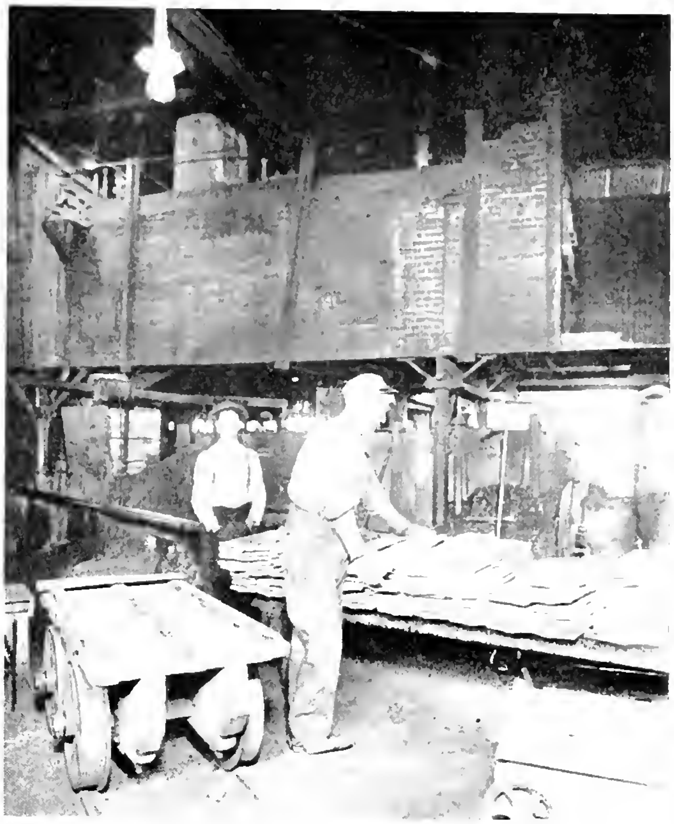


Fig. 5.—Charcoal Iron Slabs Cut to Length and Piled for Heating

Chemically the principal difference between ordinary low or a medium carbon steel and charcoal iron lies in the lower carbon and manganese content of the latter; basically, however, the difference is due to the presence of slag distributed throughout the iron in filaments and thin plates which form protective barriers against corrosion of the iron.

Administration of New Boiler Laws in Pennsylvania

Plans have been practically completed to put into effect the boiler and elevator fee laws passed by the recent legislature.

The administration of these laws necessitates the inspection of boilers and elevators by qualified inspectors of the casualty companies and of the uninsured boilers and elevators by salaried employees of the department, who must qualify for these positions by passing a rigid examination test.

The credentials of all boiler and elevator inspectors issued prior to the passage of these laws have been recalled and new credentials will be issued to only qualified inspectors of the casualty companies and to other qualified inspectors who will become salaried members of this department.

Charge to be Made for Inspections

It is expected that the fees received will meet the expenses incurred in the enforcement of the boiler act. All the owners of unused boilers shall pay a fee of ten dollars for each annual internal and external inspection of a boiler while not under pressure, which fee includes an external inspection of the said boiler under operating conditions, and the actual expenses incurred by the inspector while making the inspection. This includes the certificate fee of one dollar, which certificate is issued to all the owners of boilers, and which indicates thereon that the boiler is safe to operate at the pressure limit named in the inspector's report to the department of his examination of the boiler.

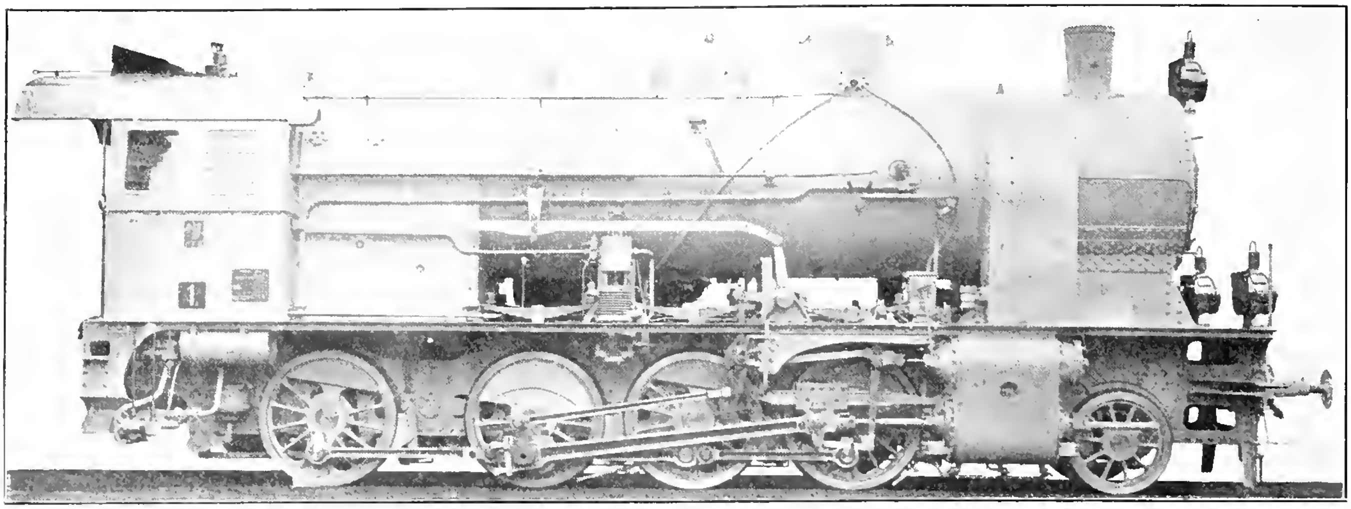
Welded Joints in Unfired Pressure-Vessels

(*Continued from page 279*)

longitudinal weld (and by this I mean a double-V weld) is not equivalent in strength to the average triple-riveted butt-strap joint; and under favorable conditions it may be permissible to allow it an equivalent efficiency, or approximately 85 percent. In making this statement I have reference to tanks which are constructed in accordance with A. S. M. E. requirements—provided these requirements are amended as was suggested at this meeting, so as to permit only double-V welded longitudinal joints.

In determining the insurability of welded vessels we place even greater reliance upon methods of construction than upon tests made after construction—such as hydrostatic and hammer tests. At the same time, there is no question but that the hydrostatic and hammer test will reveal some defective welds, and we believe that the test now prescribed by the Pressure Vessel Code should be retained. A hydrostatic pressure test of $1\frac{1}{2}$ times the safe working pressure should be applied, and the vessel should be hammer tested while under this pressure. The hydrostatic pressure should then be raised to at least twice the safe working pressure, but not to the yield point of the metal.

[The foregoing does not imply, of course, that *The Travelers* is ready to insure *any job of welding whatsoever*. The weld must be made in the right way, and by a skilled workman operating with proper equipment; and when there is a good deal at stake, it may be necessary to investigate the shop conditions under which the weld was made.]



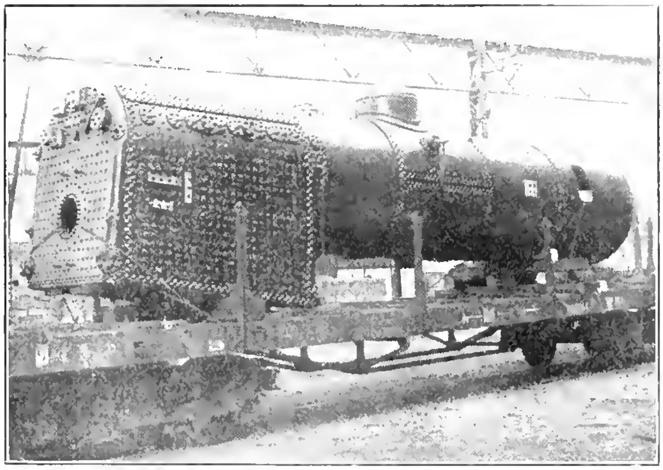
First Locomotive Built in Poland for the Polish State Railways

Consolidation Locomotives Being Built in Poland for the State Railways

By J. Dabrowski

THE new plant of the first Polish Locomotive Works at Chrzanow, Poland, has been completed and locomotives are now being delivered. The Polish Government placed an order with this company for the construction of 1,200 locomotives, deliveries to extend over a period of 10 years. The order included several types of locomotives for both freight and passenger train service. The first locomotives to be built are of the Consolidation or 2-8-0 type for handling freight traffic.

As the boiler shop of the locomotive works was not completed for operation as soon as the machine and erecting shops, the boilers for these Consolidation type locomotives are being built by the oldest boiler construction plant in the country, W. Fitzner and K. Gamper, Sosnowice, Poland. The photograph of one of these boilers loaded for shipment shows them to be of a good modern type.



Boiler for One of the Polish Consolidation Locomotives

The 2-8-0 type locomotive is used extensively in Poland. An order for 150 locomotives of this type was given to the Baldwin Locomotive Works in 1920, and 25 additional locomotives of the same design were ordered subsequently. In the future, new locomotives will probably be built in Poland provided the capacity of the local plants is sufficient.

The new Polish locomotive illustrated is equipped with a Schmidt superheater and a Knorr feedwater heater. Westinghouse air brakes for drivers and train are also provided, the air brake now being applied to all new locomotives and cars, both passenger and freight. It has a greater cylinder horsepower, tractive effort and heating surface than the Baldwin locomotive, although the weight on the drivers differs but little. A comparison of the leading dimensions of the two designs is given in the accompanying table:

Dimensions Weights and Proportions	Polish Consolidation Locomotive	
Builder	Polish Works	The Baldwin Lo-Locomotive Works
Track gage	4 ft. 8½ in.	4 ft. 8½ in.
Cylinders, diameter and stroke	24.2 in. by 26 in.	21 in. by 28 in.
Total engine weight	176,370 lb.	163,800 lb.
Tender weight	105,820 lb.	117,500 lb.
Wheel bases:		
Driving	16 ft. 7 in.	15 ft. 6 in.
Total engine	24 ft. 11 in.	23 ft. 8 in.
Total engine and tender	55 ft. 5 in.	57 ft. 3⅞ in.
Wheels, diameter outside tires:		
Driving	53¼ in.	56 in.
Front truck	39⅜ in.	33 in.
Boiler:		
Type	Straight top	Straight top
Steam pressure	184.9 lb.	191.7 lb.
Diameter, first ring, outside	71 in.	70 in.
Length over tube sheets	16 ft. 3⅝ in.	13 ft. 9¼ in.
Grate area	44.3 sq. ft.	32.1 sq. ft.
Heating surface:		
Total evaporative	2,250 sq. ft.	1,862 sq. ft.
Superheating	633 sq. ft.	420 sq. ft.
Comb. evaporative and superheating	2,833 sq. ft.	2,282 sq. ft.
Tender:		
Water capacity	5,546 gal.	5,400 gal.
Fuel capacity	17,600 lb.	23,140 lb.
General data estimated:		
Rated tractive force, 85 per cent	45,180 lb.	35,925 lb.
Cylinder horsepower (Cole)	1,945	1,520
Weight proportions:		
Weight on drivers ÷ total weight engine, per cent	85	90.7
Weight on drivers ÷ tractive force	3.32	4.14
Total weight engine ÷ cylinder horsepower	90.7	107.8
Boiler proportions:		
Comb. heat. surface ÷ cylinder horsepower	1.48	1.50
Tractive force ÷ comb. heat. surface	15.67	15.74
Tractive force × dia. drivers ÷ comb. heat. surface	834	882
Cylinder horsepower ÷ grate area	43.9	47.4

The Determination of Chimney Sizes*

By Alfred Cotton†

In this paper the author presents a simple and orderly system, based on accepted characteristics, for determining the sizes of chimneys. Under any specific conditions there is a definite static draft for a given height and a definite "maximum capacity" for any given diameter. Charts are provided which give the static draft and maximum capacity of chimneys up to 500 feet high and 25 feet diameter, from which the working draft and capacity are found by means of the fundamental curve. Other charts give factors for various atmospheric temperatures, for altitudes; and for approximate work based on boiler horsepower. A problem is worked out to facilitate an understanding of the system.

It is probable that no engineering subject is in such a chaotic state as that of chimneys. While much excellent work has been done and many formulas, tables and charts have been prepared, chimneys are nevertheless usually designed by rule of thumb, and there are plenty of cases where their performance is either much greater or much less than was expected.

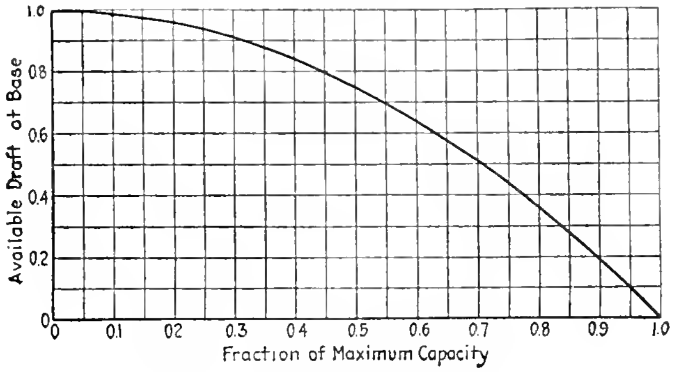


Fig. 1.—Relation of Draft Fraction to Capacity Fraction

It is believed that the method of proportioning chimneys outlined in what follows has the merit of giving definite sizes which are entirely free from conjecture, in a very simple and consistent manner.

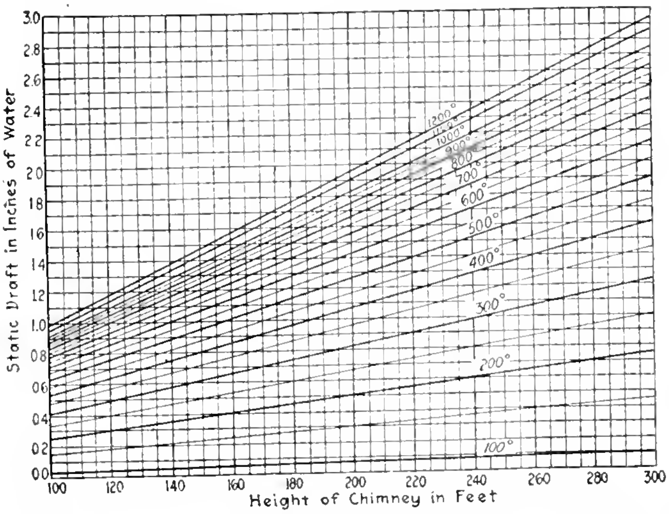


Fig. 2.—Static Draft of Chimneys from 100 to 300 Feet High with Gas Temperatures from 100 to 1,200 Degrees F. at Sea Level with Atmosphere at 60 Degrees F.

*Contributed by the Fuels Division and presented at the spring meeting, Montreal, Canada, of The American Society of Mechanical Engineers. Abridged.

†Chief of research department, Heine Boiler Co., Mem. A. S. M. E.

A Description of the Method Employed

It is convenient to consider the available draft at the chimney base as being the static draft less the draft lost by chimney friction and by acceleration of the gases, and this must equal or exceed the draft necessary to operate the boiler, etc.

The static draft is the vacuum prevailing under an imaginary condition when no gases are flowing. It is an absolutely definite quantity for any given circumstances and forms the starting point of this method.

The chimney friction varies as the square of the velocity of the gases. If the velocity is progressively increased, a point is reached where the chimney friction is equal to the static draft. This is the "maximum capacity," and it is just as absolute and definite a quantity for any given circumstances as is the static draft from which it is determined and it forms the end point of the method.

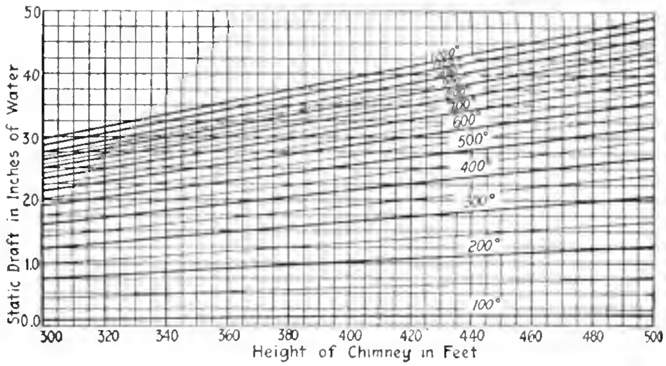


Fig. 3.—Static Draft of Chimneys from 300 to 500 Feet High with Gas Temperatures From 100 to 1,200 Degrees F. at Sea Level with Atmosphere at 60 Degrees F.

(Curves marked with mean temperature of gases in degrees F.)

The draft loss due to chimney friction is in direct proportion to the height of the chimney. So also is the static draft. If we double the height of the chimney, we double both the static draft and the draft loss, and the maximum capacity is unaltered.

Since the chimney friction increases as the square of the velocity of the gases, the resulting curve is a parabola in all cases. This curve is presented in Fig. 1, and relates the load expressed as a fraction of the maximum capacity to the available draft expressed as a fraction of the static draft. This is a fundamental curve which applies to all chimneys at all temperatures of gases and of the atmosphere and at all altitudes.

Static Draft

Figs. 2 and 3 give the static draft for chimneys 100 to 500 feet high at sea level dealing with gases up to 1,200 degrees F. in temperature when the atmosphere is at 60 degrees.

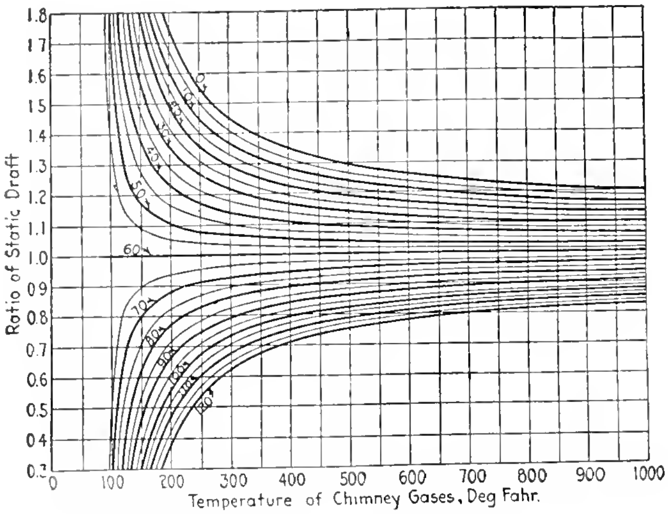


Fig. 4—Relation of Static Draft of Chimneys with Temperatures of Atmosphere from 0 to 120 Degrees F. to That at 60 Degrees F.

(Curves marked with temperature of atmosphere in degrees F.)

Another chart in the complete paper deals similarly with chimneys from 0 to 100 feet in height. Fig. 4 gives factors with which to multiply the static draft found from Figs. 2 and 3 to obtain the static draft for atmospheric temperatures other than 60 degrees.

Temperature of Gases in Chimney

The author's article on Loss of Heat in Brick Chimneys, published in *Power Plant Engineering*, Aug. 1, 1921, and which forms an appendix to the complete paper, includes some curves of temperature drop. These lead to the factors of Fig. 5, by which the mean temperature in the chimney may be found.

Altitude and Static Draft

The static draft at any barometric pressure B in inches of mercury is that at sea level multiplied by $B/30$. If the same load is to be carried at altitude as would be carried at sea level, then the same weight of gases must be dealt with. Since the density of the gases is less, their velocity must be higher, and the height of chimney necessary at altitude to provide sufficient draft to do the same work as at sea level, will be the sea-level height divided by $(B/30)^2$, or multiplied by its reciprocal which is given in Fig. 6.

Procedure (Masonry Chimneys):

A = observed temperature of atmosphere
E = observed temperature of gases entering chimney
P = percentage appropriate to diameter and height as read from chart
G = temperature of gases entering chimney above that of atmosphere $= E - A$
C = average temperature of gases in chimney above that of atmosphere $= G \times P$
$C + A$ = average temperature of gases in chimney.

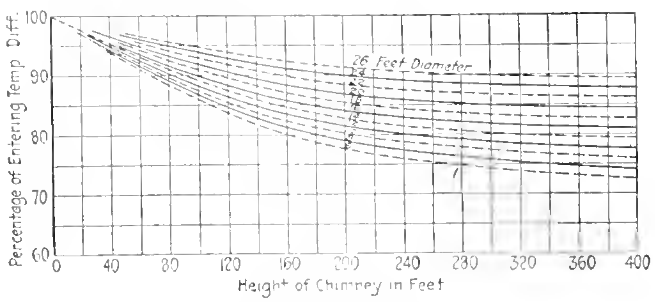


Fig. 5.—Factors for Finding the Mean Temperature of the Gases in Chimneys

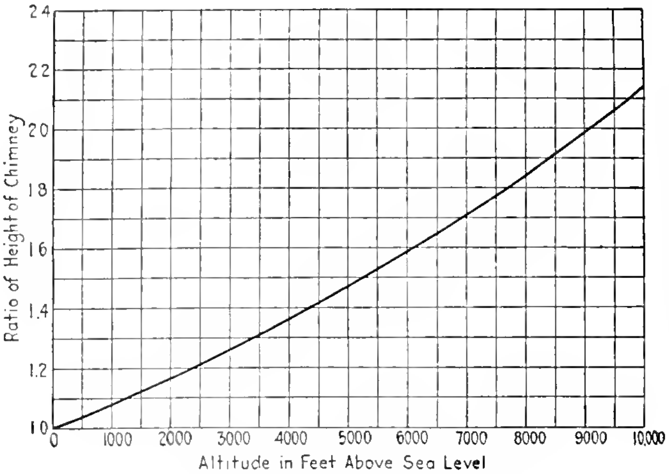


Fig. 6.—Effect of Altitude on Height of Chimneys

Maximum Capacity

Menzin, in his paper on Proportioning Chimneys on a Gas Basis, Trans. A.S.M.E., 1916, went so carefully over all the available data on chimney friction that the formula he presented has been used. Fig. 7 gives the maximum capacities of chimneys from 5 to 25 feet in diameter for various mean temperatures of gases with the atmosphere at 60 degrees at sea level. Other charts in the complete paper cover the range for diameters of from 0 to 10 feet. The maximum capacities as read from Fig. 7 are to be multiplied by the appropriate factor read from Fig. 8 when the atmospheric temperature is other than 60 degrees F.

It is convenient to assume that the velocity of the gases remains constant. Then the maximum capacity at altitude is that at sea level multiplied by $B/30$.

Acceleration of Gases

The pressure difference required to accelerate the gases is conveniently stated as draft loss, and curves showing this draft loss at maximum capacity for each diameter have been drawn in Fig. 9, for different temperatures. Other charts in the complete paper covers the range for diameters of from 0 to 10 ft. The fraction of the draft loss for any desired fraction of the maximum capacity is the same for all maximum capacities. Fig. 10 gives this fraction.

The draft loss at sea level multiplied by $B/30$ gives the draft loss for altitudes.

Available Draft

Enter Fig. 1, with the ratio of available draft to static draft, and read the fraction of maximum capacity. Divide the required weight of gases by this fraction and use the resulting maximum capacity to find the requisite diameter. Or with given diameter, read the maximum capacity and state the required capacity as a fraction of it. Divide the required draft by the fraction read from Fig. 1 and get the equivalent static draft. Add the draft required to accelerate the gases and read the height of chimney from Fig. 2 or Fig. 3. Several combinations of height and diameter can be found for any circumstances very quickly.

Draft Required

The draft required at the base of the chimney is made up as follows:

1 *Vacuum Over Fuel Bed.* Fig. 11 shows the vacuum required in the furnace chamber for burning various fuels. The values are fair averages which accord with the author's experience with reasonably clean fires when hand firing and with average conditions of stoker operation. The broken-line curves were kindly supplied by Mr. Thomas A. Marsh,

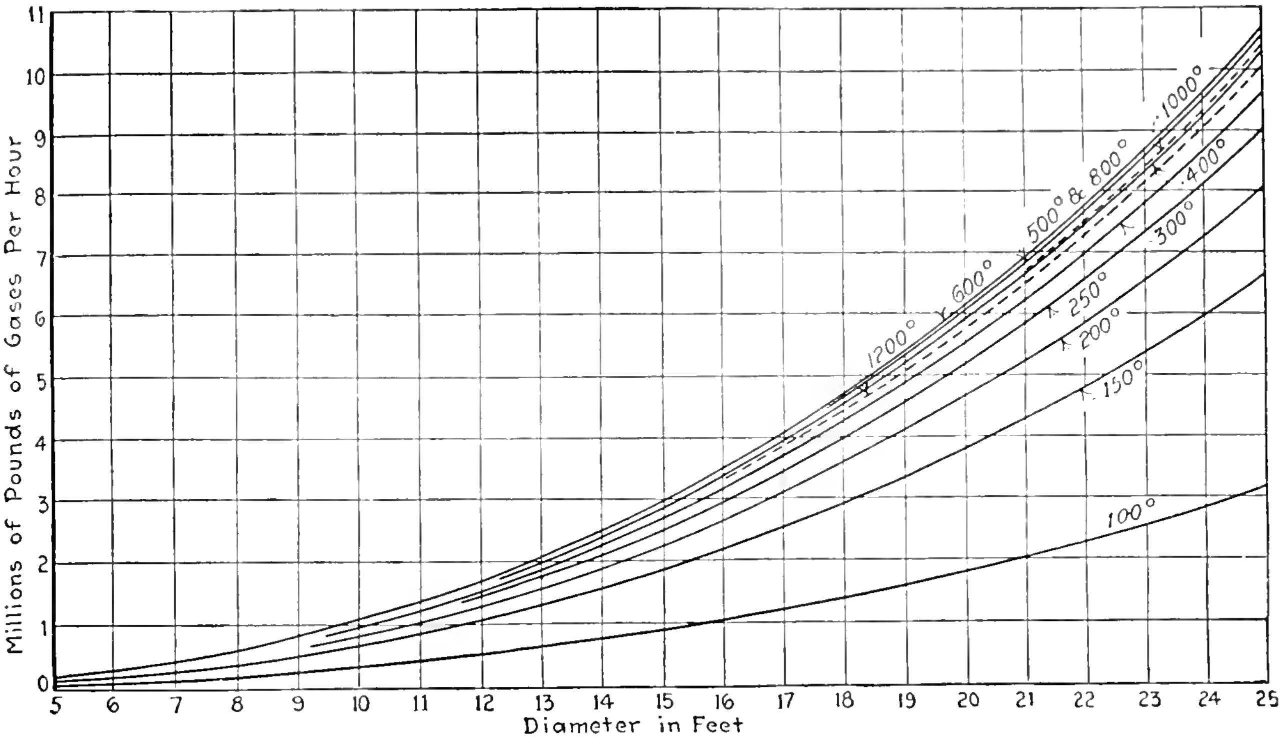


Fig. 7.—Maximum Capacity of Chimneys from 5 to 25 Feet in Diameter at Different Gas Temperatures from 100 to 1,200 Degrees F. at Sea Level with Atmosphere at 60 Degrees F.

Mem. A.S.M.E. With forced draft, a vacuum over the fire of about 0.1 in. should be maintained.

2 *Draft Loss Through Boiler Setting.* A curve should usually be obtained from the boiler manufacturer based on some proportion of excess air with the fuel to be used.

The draft loss through a horizontal, diagonally baffled, 14-high watertube boiler burning bituminous coal with 13 percent of CO_2 in the flue gases is given in Fig. 12.

The effect of an alteration in the amount of excess air as indicated by the proportion of CO_2 in the flue gases is shown approximately by the curves drawn in Fig. 13. Precise factors are not possible, but these are sufficiently accurate for the present purpose. The draft loss for any percentage of CO_2 is to be multiplied by the appropriate factor to find the draft loss at some other percentage of CO_2.

3 *Draft Loss Through Damper.* Some may prefer to allow a little draft loss through the damper, the damper being not fully open, as a factor of safety. But this is quite unnecessary with the method of treatment being described. Of course, in some ill-designed plants there may be a real draft loss through the damper frame owing to its being too small, or through the damper's causing serious distortion of the stream lines when fully open.

4 *Draft Loss Through Flues.* The draft loss through flues is commonly taken as 0.1 in. of water for each 100 feet of length and 0.05 inch for each right-angle turn. This value results in the curves of gas weights and velocities of Figs. 14 and 15 for a temperature of 540 degrees and for rectangular flues whose sides have a ratio of 2:1. Other figures in the complete paper give factors for finding the weight and velocity at other temperatures for the same draft

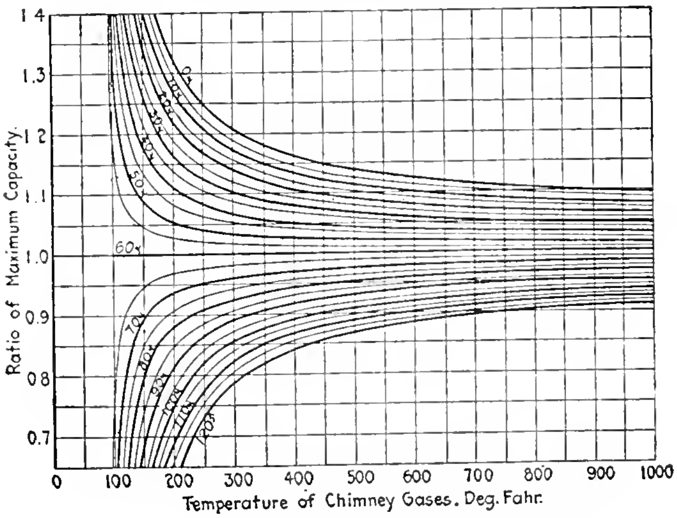


Fig. 8.—Relation of Maximum Capacity of Chimneys with Temperatures from 0 to 120 Degrees F. to That at 60 Degrees F.

(Curves marked with temperature of atmosphere in deg. fahr.)

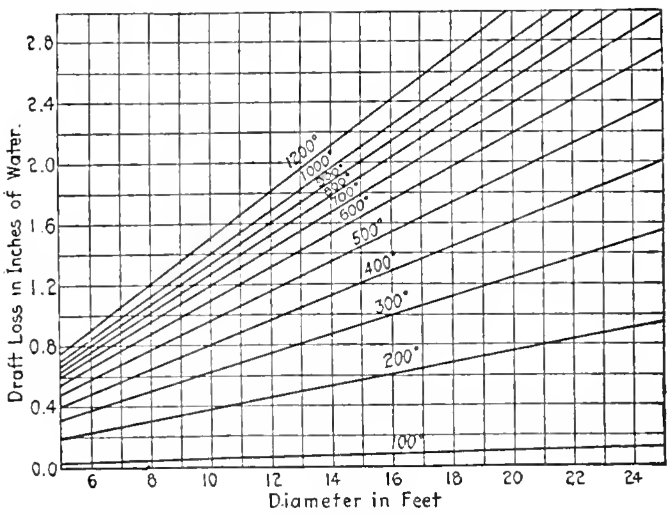


Fig. 9.—Draft Loss Due to Acceleration of Gases at Maximum Capacity of Chimneys from 5 to 25 Feet in Diameter with Temperatures of Gases from 100 to 1,200 Degrees F. at Sea Level

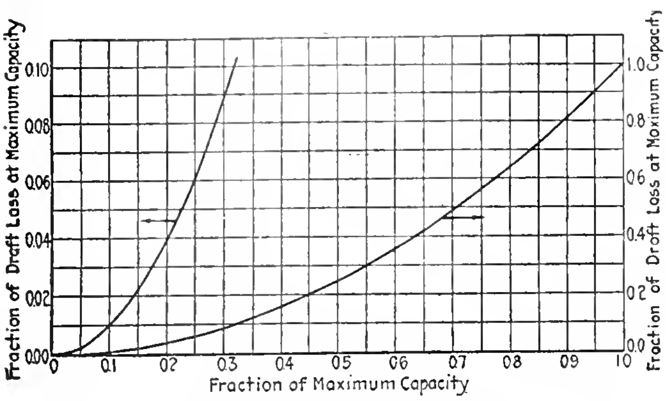


Fig. 10.—Relation of Draft Loss Fraction Due to Acceleration of Gases to Capacity Fraction

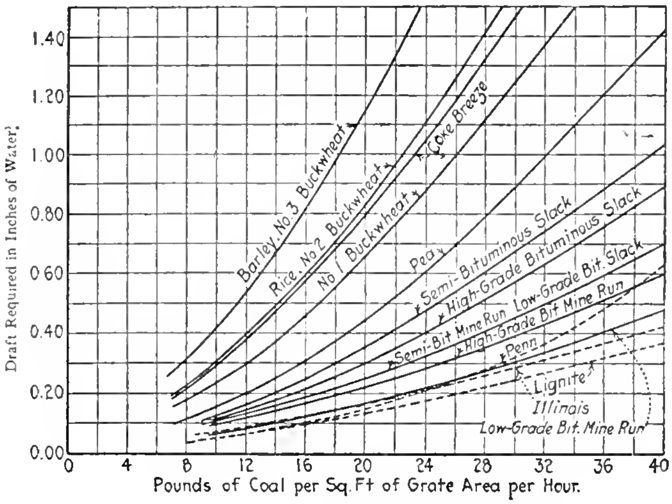


Fig. 11.—Draft Loss Through Fuel Bed

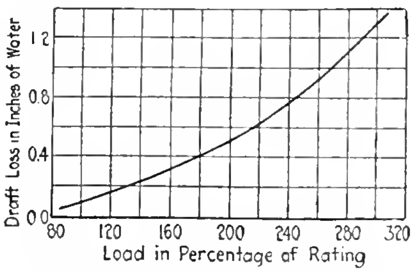


Fig. 12.—Draft Loss Through Diagonally Baffled Boiler 14 Tubes High with Superheater, Burning Bituminous Coal with 13 Percent of CO_2 in Flue Gases at Sea Level

loss, and the effect of the shape of the cross-section of the flue. A further development results in the curves of Fig. 16 which are based on the gas weights of Table 1.

The loss due to elbows is generally assumed as 0.05 in. for right-angle turns whose inside radius is not less than the width of the flue.

The effect of different amounts of excess air on the draft loss in flues is the same as for the boiler setting as shown by Fig. 13.

TABLE I. WEIGHT OF FLUE GASES PER BOILER HORSEPOWER

Conditions	Pounds of gases per horsepower
Coal, natural draft	90
Coal, forced draft	60
Natural gas	60
Oil	45
Blast-furnace gas	100

Weight of Gases

The weight of gases to be dealt with from any given fuel depends upon the proportion of excess air. It is convenient to calculate the weight of gases with different proportions of excess air per pound of "combustible." Any percentage of refuse, including unburned coal going to the ashpit, can then be used to find the weight of gases per pound of dry coal or of coal "as fired." The efficiency of the boiler and furnace will determine the weight of coal per horsepower

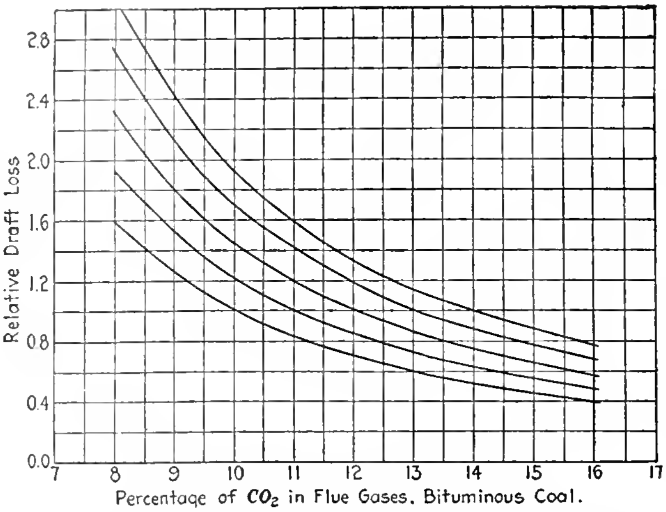


Fig. 13.—Relative Draft Loss through Boilers Burning Bituminous Coal with Varying Proportions of Excess Air

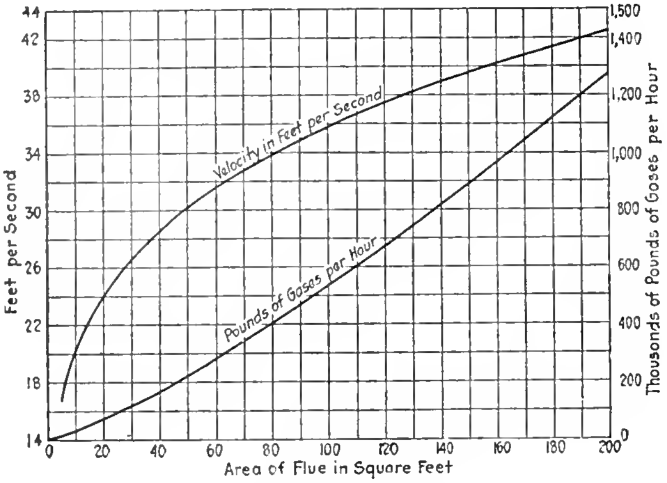


Fig. 14.—Working Capacity of Rectangular Flues from 0 to 200 Square Feet in Area of Cross Section, with Sides in Ratio of 2:1 with Gases at 540 Degrees F. at Sea Level, Giving a Draft Loss of 0.1 Inch of Water per 100 Feet of Length

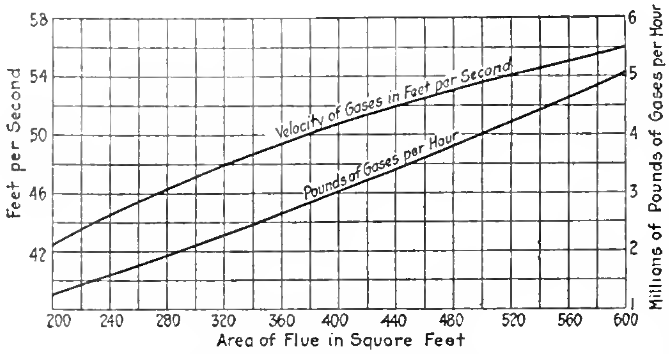


Fig. 15.—Working Capacity of Rectangular Flues from 200 to 600 Square Feet in Cross Sectional Area, with Sides in Ratio of 2:1 with Gases at 540 Degrees F. at Sea Level, Giving a Draft Loss of 0.1 F. of Water per 100 Feet of Length

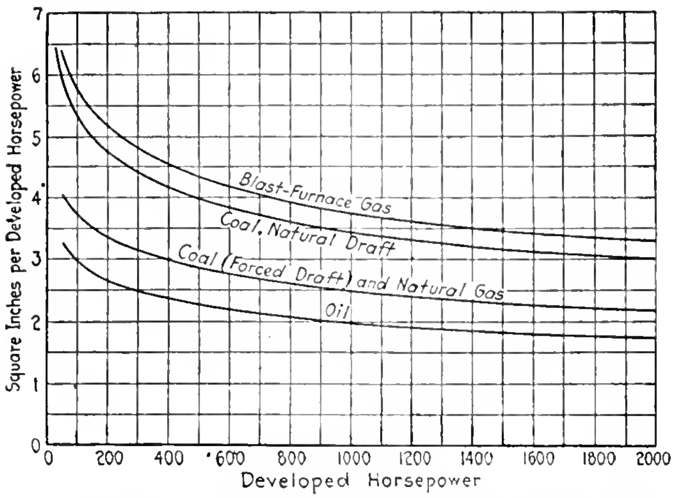


Fig. 16.—Area of Rectangular Flues in Square Inches per Developed Horsepower with Sides in Ratio of 2:1 Which Will Give a Draft Loss of 0.1 Inch of Water per 100 Feet of Length at Sea Level

or per unit weight of steam, and the weight of coal to be burned can then be found.

Chimneys for induced draft are computed in exactly the same manner as in other cases. Since it often happens that loads are increased later owing to the ease of doing so with induced draft, it is advisable to allow at least 0.2 inch of available draft at the fan discharge.

Fig. 17 is drawn for a working capacity of 30 percent of the maximum capacity. The natural-draft curve is computed at 90 pounds of gases per boiler horsepower, the forced-draft curve at 60 pounds, and the oil-burning curve at 45 pounds.

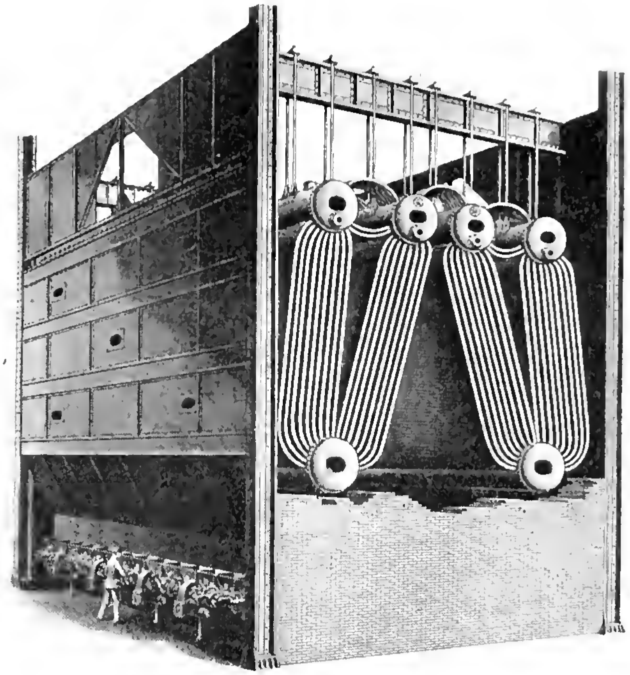
(*To be continued in the November issue*)

Giant Boiler Contains Nearly Seven Miles of Tubes

A GIANT boiler of record-breaking size, said to be the largest boiler in the world, was recently installed in a Detroit plant (the Detroit-Edison Company). It contains 2,236 tubes of 3¼ inches diameter, having a total of 35,596 lineal feet, or about 6¾ miles. The distance measured from the street level to the boiler room floor is about 30 feet.

Main Particulars of the Boiler

This boiler has 29,820 square feet heating surface, and based on 10 square feet of heating surface per horsepower, it has 2,982 horsepower. It is equipped with 28 forced draft, multiple retort stokers, 14 at the front and 14 at the rear. The space requirements are 31 feet 8 inches width



Watertube Boiler Having 29,280 Square Feet Heating Surface

by 31 feet 0 inches depth by 47 feet 8 inches height. The weight of the boiler and the steel work for carrying it is about 500 tons. This mammoth piece of engineering consumes 420 tons of coal every 24 hours. The water evaporated is about 225,000 pounds every hour so that in actual size and performance it is entitled to the designation of "giant."

Work of the A. S. M. E. Boiler Code Committee

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the secretary of the committee to all of the members of the committee. The interpretation, in the form of a reply, is then prepared by the committee and passed upon at a regular meeting of the committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer.

Below are given the interpretations of the committee in Cases Nos. 391, 399 (reopened), 416, 419, 421 and 422, as formulated at the meeting of June 26, 1923, and approved by the council.

In accordance with the committee's practice, the names of inquirers have been omitted.

Case No. 391—*Inquiry:* Permission is requested, under Par. 245, to operate watertube boilers with the tubes secured to malleable iron headers at pressures greater than 200 pounds per square inch. Also, attention is called to the fact that Par. 246*b* requires that the hydrostatic test be applied to all headers with tubes attached, whereas in certain cases it is not customary to attach the tubes until the boilers are erected in the field.

Reply: It has been proposed to revise the requirements of the Boiler Code in regard to the pressure allowance on watertube boilers when the tubes are secured in malleable iron headers, as follows:

"Par. 245—Change '200 pounds' in the third line to '350 pounds.'

"Par. 246*a*—Add the following to this section: The malleable iron used for headers of watertube boilers shall conform to the specifications for malleable castings given in Pars.

111-120 (the paragraphs to be changed to conform with latest A.S.T.M. Specification).

"Par. 246*b*—Change '1,500 pounds' in the third line to '2,250 pounds.' Change the last sentence to read: A hydrostatic test applied to all new headers or elements with tubes attached shall be 500 pounds per square inch when cast iron headers or elements are used, and two and one-half times the working pressure when malleable iron is used, although the minimum test pressure with malleable iron headers or elements shall be 500 pounds per square inch."

Case No. 399 (Reopened)—*Inquiry:* (*a*) Is any allowance permissible in the value of T in the formula in Par. 199 of the Code, for the combined thickness of the head and washer applied on the outside thereof under the nut of the through stay, when the washer is of large size and riveted to the head?

(*b*) Is the same increase in the value of T in the formula in Par. 199 applicable when a doubling plate is riveted on the inside of the segment of a head as if it were riveted on the outside of the segment?

Reply: It is the opinion of the committee:

That the Code does not stipulate whether the doubling plate shall be placed on the inside or outside; it is optional, but the inside plate of your design is preferable;

That the doubling plate must cover the entire segment and be riveted to the head in accordance with the requirements of the Code;

That 75 percent of the combined thickness of head and doubling plate shall be used in determining T;

That the value of $C = 175$ may be used for washers without doubling plate when stays are fitted with inside and outside nuts and outside washers, where the diameter of the washers is not less than $0.4p$ and the thickness not less than T;

That $C = 175$ may be increased by 15 percent when both washers and doubling plates are used, designed in accordance with the Code;

That the Code does not provide any additional value for C on account of the washers being riveted to the plate.

Case No. 416—*Inquiry:* Information is requested as to the method of calculating, under the Rules in the Boiler Code, the required thickness of the bottom plate of the combustion chamber of a wet-back Scotch marine type of boiler when this bottom plate is curved upward or inward to the form of an arched surface between the points of attachment of the different furnaces and thus requires no staying.

Reply: It is the opinion of the committee:

That there is no rule in the Code exactly covering the construction submitted;

That the rule which has been followed from the General Rules and Regulations provided by the Board of Supervising Inspectors Steamboat-Inspection Service, Department of Commerce, is not applicable to the design submitted;

That the application of this rule to the case in hand does, however, provide a safe construction. Par. 239*a* of the A.S.M.E. Boiler Code may be used, which is equivalent to the Board of Supervising Inspectors' rule above quoted;

That a safer construction would be obtained if the arch curved plate were either stayed to the outer shell or reinforced;

That it would be better construction to build boilers with separate combustion chambers, with the bottoms so designed that they need not be stayed.

Case No. 419 (In the hands of the committee)

Case No. 421—*Inquiry:* Is it permissible to electrically weld a boiler shell, particularly the longitudinal joint, if sufficiently reinforced with bands as shown in the blue print, so that no stress is carried by the welded joint?

Reply: It is the opinion of the committee that a boiler so constructed would not meet the Rules in the Code unless the bands are made strong enough to withstand the full boiler pressure without giving any credit to the holding power of the welded shell, and unless some other method than the autogenous welding shown in the blue print is used for attaching the heads to the shell (see Par. 186 of the Code).

Case No. 422—*Inquiry:* Will it be acceptable, under the Rules of the A.S.M.E. Boiler Code, to use angle-iron attachments for the heads to the shell of cylindrical boilers, instead of the American practice of flanging the heads, and also to bolt the furnace front sheet and the rear tube plate to the boiler heads instead of riveting?

Reply: It is the opinion of the committee that provided the design is in accordance with the requirements of the Code as to material, stresses, construction, workmanship, inspection, and stamping, the boiler so constructed would meet the requirements of the Code.

Boiler Manhole Doors

Quite a large number of explosions in marine boilers can be traced to defects in the fittings of manhole doors, and even when these explosions do not have fatal results, but result merely in the blowing of the contents of the boiler into the stokehold, the loss of time and money involved may be considerable. Such an explosion, happily unattended by fatal consequences, occurred recently to the boiler on a steam trawler (off the English coast) and from the official report of the inquiry into the causes of the explosion, held under the Boiler Explosion Acts, it appears that the explosion was entirely due to the blowing out of the joint between the flanged part of boiler-end plate and the manhole door. Following on the excessive clearance between the spigot of the door and the flange on the boiler plate excessive wastage had occurred, and the boiler was scheduled for repair at the conclusion of the voyage during which the explosion took place. It cannot be too frequently emphasized that at any point on a boiler where leakage of steam or of water occurs very rapid wasting of the metal parts is sure to follow, and any such leakage should, therefore, be promptly prevented. In the case of manhole doors, it is essential that the flange of the boiler plate should fit snugly into the manhole door preferably on both sides of the flange, but, if a grooved manhole door is not provided, at least on the inner surface of the flange, so as to provide support to the sides of the packing. Otherwise there is always the tendency for the packing to blow out with the consequences indicated above.—*Shipbuilding and Shipping Record*, London, England.

Annual Fall Meeting of American Welding Society

(*Continued from page 276*)

discussion will be centered on four important topics, namely, the interest shown in section meetings, the journal of the American Welding Society, ways and means of increasing membership and the general promotion of welding.

One of the principal sessions of the program is the industrial application session scheduled for Wednesday afternoon. All members realize that there are a large number of industries who are familiar with welding in a very vague way through infrequent newspaper accounts. It is their duty to call attention to the enormous possibilities of welding and the economies which result from its use. The Meetings and Papers Committee are preparing a comprehensive report on the industrial application of welding and the relation of the Society to the welding industry. There will be invited as guests representatives from all of the industries that should be interested in welding, living in Pittsburgh and its vicinity. Every member is requested to make a special effort to advertise this session and attend himself.

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CONTENTS

That steam users in both stationary and railroad practice, and to a lesser extent perhaps in marine practice, are looking towards the adoption of much higher steam pressures and temperatures as a means for effecting further power plant economies is evidenced by recent developments both in this country and abroad.

Early this year the Commonwealth Edison Company of Chicago ordered a boiler which is to supply steam at 1,200 pounds per square inch working pressure. Arrangements have also been made for the installation of a boiler working at the same pressure by the Edison Illuminating Company of Boston. In both cases the boilers were designed by the Babcock and Wilcox Company of New York.

Boilers delivering steam at from 800 to 1,000 pounds per square inch are in use in Sweden and Germany and pressures up to 1,500 pounds per square inch are being considered. In one case in England steam is to be generated at 3,200 pounds per square inch in an experimental plant.

From the foregoing it may be said that at the present time steam pressures up to 1,500 pounds per quare inch and temperatures up to 750 degrees are at least commercial and certainly indicative of a new field of development for the boiler manufacturer.

To meet the demand for the design and construction of boilers capable of supplying steam a t such high pressures and high degrees of superheat, both the boiler maker and the steel maker will have new problems to solve. In the case of the 1,200-pound pressure boilers mentioned above, for instance, the design calls for steam drums 48 inches in diameter with walls 4 inches thick made of forged steel, a problem quite different from that with which the average boiler maker is accustomed to deal. If such problems are to be successfully met by the boiler makers themselves, they must not only be progressive but also resourceful and competent to undertake responsibilities of a new order.

Fusion welding is gradually coming into its own as a safe, rapid and economical method of construction and repair in certain classes of boiler and tank work. The high pressure boiler is practically the only type of pressure vessel construction in which its use is prohibited.

In the section of this issue devoted to letters from our readers a short illustrated description of the largest all-welded steel boiler built in America is given which indicates in a measure the adaptability of the process to boiler work and the possibility of its use in boilers of higher pressure. The longitudinal seam construction with its unique method of reinforcement apparently insures an extremely safe boiler.

From the viewpoint of the insurance company, fusion welding is entirely acceptable in many classes of boiler and tank work as evidenced by the statements made by a representative of one of the most prominent insurance companies in the country at the recent welding conference held in New York to discuss the results of the welding investigation carried out by the Bureau of Standards in Washington. For nearly two years this company has insured welded pressure vessels of many kinds, working under high as well as low pressures—and with longitudinal as well as girth seams and heads fusion welded.

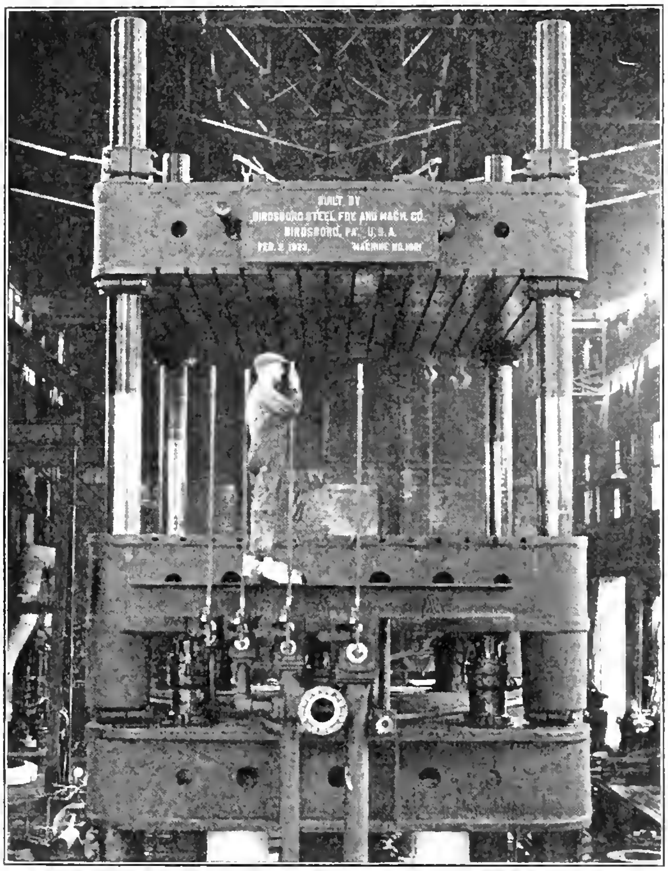
Up to this time this company when considering a pressure vessel for insurance has arbitrarily assumed a joint efficiency of 50 percent. In the light of the data made available by the Bureau of Standards, however, there would seem to be no objection for insurance purposes in allowing an efficiency as high as 85 percent for a double V longitudinal welded joint when the construction is carried out by competent operators and in accordance with A.S.M.E. requirements.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Large Flanging Press for Boiler Shop

A FLANGING press, said to be the largest ever built, has recently been constructed for use in a railway shop. It uses an accumulator pressure of 1,500 pounds per sq. in., making a capacity of 1,200 tons. The machine is of the moving-up type, equipped with modern labor and power saving devices and safety appliances. A foundation pit, 8 feet wide, 25 feet long and 18 feet deep, is required as



1,200-Ton Hydraulic Press Built by the Birdsboro Steel Foundry & Machine Co.

the floor level in which the press is placed comes slightly below the face of the middle platen, which is the moving member.

The press, built by the Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa., is of the four-column type, each column being 13 inches in diameter and 30 feet in length. The clearance between columns is 15 feet one way and 11 feet 11 inches the other way. The platens are 15 feet by 18 feet 3 inches, permitting the flanging of large steel plates. This construction makes available a flanging bed 15 feet by 15 feet. The top and moving platens are provided with a multiplicity of longitudinal T-slots to accommodate bolts for fastening dies.

The columns have long threads on the upper ends, thereby providing an adjustment between the top and moving platens of from 12 feet maximum to 5 feet minimum. The inner nuts supporting the upper platen are made in halves, and the outer nuts are split on one side to permit the use of a wedge for slackening while they are being raised or lowered in adjusting the clearances.

Six ranges of power may be exerted by the press, which has three main cylinders and plungers 26 inches in diameter each with a lift of 6 feet. By admitting 1,500 pounds accumulator pressure to the center cylinder, only 400 tons will be exerted. When pressure is admitted to the other two 26 inch cylinders simultaneously, a pressure of 800 tons will be obtained, and by applying pressure to the three cylinders, 1,200 tons will be obtained.

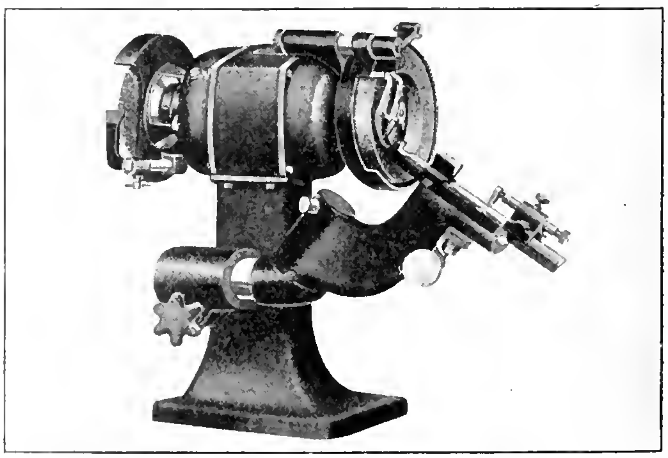
It is possible to exert three additional pressures by using the four jack rams in conjunction with either of the above three combinations. These rams are 9 inches in diameter and also are used for raising and controlling the motion of the moving platen while running up to the work and to perform light flanging.

An auxiliary cylinder is mounted on the center of the moving platen and moving therewith for stripping the work from the flanging dies. The hydraulic pressure is transmitted to this cylinder through a set of swivel joints. The press is of cast steel construction throughout, with the exception of the plungers, which are of chilled iron, ground and polished, and the tension bolts, which are of steel forged from metal cast ingots. The total weight of the press is over 300 tons.

Bench-Type Twist Drill Grinder

THE bench-type twist drill grinder illustrated is an interesting new development of the Gallmeyer & Livingston Company, Grand Rapids, Mich., successor to the Grand Rapids Grinding Machine Company. The grinder is driven by a self-contained motor, enabling it to be placed in any position in the shop toolroom where most convenient.

In the basic principles of design and operation it conforms to other Grand Rapids twist drill grinders. It has a diamond truing device and the diamond is furnished as part



Bench Grinder for Twist Drills From No. 52 to 1¾ in.

of standard equipment for dressing the wheel. The holder is automatically placed in the right relationship with the grinding wheel so that it is close enough to grind the drills accurately and at the same time, the stop makes it impossible to bump the front of the holder into the grinding wheel. The machine illustrated is the A-7-T type with a capacity for drills from No. 52 to 3/4 inch. It is also made with a drill holder having a capacity of from 1/8 inch to 1 1/2 inch drills, in which case it is designated style B-7-T.

Wheel-Portable Rivet Forges

A NEW line of oil-burning, wheel-portable rivet forges, designated as Nos. 1, 2 and 3, for use in boiler shops, car repair yards, and structural shops, respectively, has been placed on the market by the Johnston Mfg. Co., Minneapolis.

The general construction may be noted from the accompanying illustration. The frame is built on the "triangle" principle to permit of maximum rigidity, and the tongue is pivoted and acts as a guard for the burner. A large foot is provided to prevent sinking in soft ground. The wheels are 34 inches in diameter and 3 inches wide and are mounted in roller bear-

New Oil Burning Rivet Forge

ings. The forge is designed to burn fuel oil or any lighter oil. The automatic oil regulation provided is emphasized as maintaining a constant character of flame, eliminating scaling and smoking due to variable air pressure, and maintaining high combustion efficiency. The entire floor of the heating chamber is visible to the operator as he stands normally, without stooping.

The charging opening is 6 inches wide and 5 inches high and is said to maintain its shape and size for a long period, thereby saving oil and maintaining best operating conditions. An air curtain pipe is provided to deflect the hot gases upward. The forge is designed for relining with standard firebrick or special tile. The tank capacity is 20 gallons. The floor space occupied is 2 feet 9 inches by 3 feet 10 inches and the shipping weight is 825 pounds.

In the Johnston non-clogging vacuum oil burner used, the oil supply is regulated indirectly by an air valve, which, it is said, cannot clog or vary, it being claimed that the burner operates continually without clogging or varying on oil containing so much free carbon and dirt that the usual burner will not maintain a fire without constant attention.

The burner has only two working parts, two needle point air valves, one of which regulates the compressed air and the other regulates the oil feed indirectly. The oil regulating air valve is plainly marked as shown, and is operated in the same way as other valves. High vacuum and large oil connections are provided in order that the burner may handle thick heavy oils. The oil feed increases and decreases automatically with the air pressure, and uniform flame is said to be maintained regardless of large variations of pressure in the air lines. The elimination of the necessity for readjustment of the oil feed, thus leaving the operator free to assist in other work, is a feature emphasized.

BUSINESS NOTES

The Superheater Company is preparing plans for the erection of a 120 feet by 210 feet addition to its plant at East Chicago, Ind., to cost approximately $75,000.

John Baker, of the mechanical department of the Chicago, Rock Island & Pacific, has been appointed vice-president of the Locomotive Firebox Company, with headquarters at Chicago.

The Prime Manufacturing Co., Milwaukee, Wis., contemplates the erection of a modern brass foundry of approximately 15,000 to 18,000 square feet. No definite plans have as yet been made.

S. G. Eastman, western sales manager of the Niles-Bement-Pond Company, with headquarters at San Francisco, Cal., has been transferred to Chicago, to succeed G. F. Mills, Chicago sales manager, retired.

The American Car & Foundry Company has purchased a tract of land 260 feet by 1,931 feet extending from the south branch of the Chicago river almost to Blue Island avenue and fronting on Wood street, Chicago, from the Edward Hines Lumber Company.

George F. Murphy, having completed the reorganization of the New York office of the Heine Boiler Company, St. Louis, Mo., has taken charge of the Philadelphia territory, with headquarters in the Pennsylvania Building, Philadelphia, Pa.; Harold P. Childs, formerly special representative of the executive offices of the General Electric Company, New York, has been appointed manager of the New York City office of the Heine Boiler Company, with headquarters at 11 Broadway; J. R. Fortune, formerly manager of the Detroit office, has assumed charge of the territories heretofore covered by the Pittsburgh, Cleveland and Detroit offices, with headquarters in the Dime Bank Building, Detroit, and in the Park Building, Pittsburgh. The Cleveland, Ohio, office has been discontinued.

W. E. Corrigan, of the sales department American Locomotive Company, has been appointed general sales representative of the company on the Pacific Coast with the title of district sales manager and headquarters in the recently established branch office, Rialto Building, San Francisco, Cal. Mr. Corrigan entered the service of the American Locomotive Company in 1909 and is a graduate of the four-year course in locomotive construction which the company conducts in its engineering department in Schenectady. Since 1920, he has served for two years in the sales department at New York, as salesman for Alco accessories in the middle western territory and subsequently to the post on the Pacific Coast.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

What is a Boiler Maker?

Q.—What is a boiler maker? How far does his knowledge and practice extend? A manager came to me and asked me to make a boiler to generate steam for a small engine he wanted to operate. He did not know the horsepower of the engine. How would I act in such a case or is it a boiler maker's job?—G. C.

A.—A master boiler maker is a master mechanic who should understand the principles of boiler design, construction, laying out and shop management. A boiler maker is a mechanic who can handle the various branches of the boiler maker's trade, such as fitting up, riveting, chipping and calking, tubing and staying, repairing and some laying out. Some boiler makers are all around mechanics and can handle equally well, all of these branches, others are specialists in one or more of them.

The question put up to you on the design of a boiler for an engine of an unknown size was not fair. The boiler maker is not expected to design boilers, as this comes under the head of mechanical engineering.

Stay Calculations for Wrapper Sheets

Q.—Paragraph 212-b of Part I, Section 1 of the A.S.M.E. Boiler code reads as follows:

"The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined .... by the method which follows ....:

$$F = \frac{11{,}000\, t \times E}{R - s \Sigma \sin \alpha}$$

in which:

α = angle any crown stay makes with vertical axis of boiler.
$\Sigma \sin \alpha$ = summated value of $\sin \alpha$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.
s = transverse spacing of crown stays in crown sheet, inches.
E = minimum efficiency of wrapper sheet through joints or stay holes.
t = thickness of wrapper sheet, inches.
R = radius of wrapper sheet, inches.
P = working pressure of boiler, pounds per square inch.
11,000 = allowable stress, pounds per square inch.

Will you kindly give me an illustration of the use of this formula in spacing stays for a locomotive firebox? I do not understand what is meant by the summated value of $\sin \alpha$.—R. L. P.

A.—The solution given for the example illustrated in Fig. 1 covers the requirements of Par. 212, of the 1918 edition of the A. S. M. E. Code. The arrangement Fig. 1, for the stays is not in accordance with the requirements of firebox staying, but is indicated in this manner to illustrate the problem.

Consider the wrapper sheet to be ½ inch in thickness, and formed to a radius of 36 inches, ⅞-inch stays, spaced 7.07 inches apart each way. The angles the stays make with the vertical axis x-x are all shown.

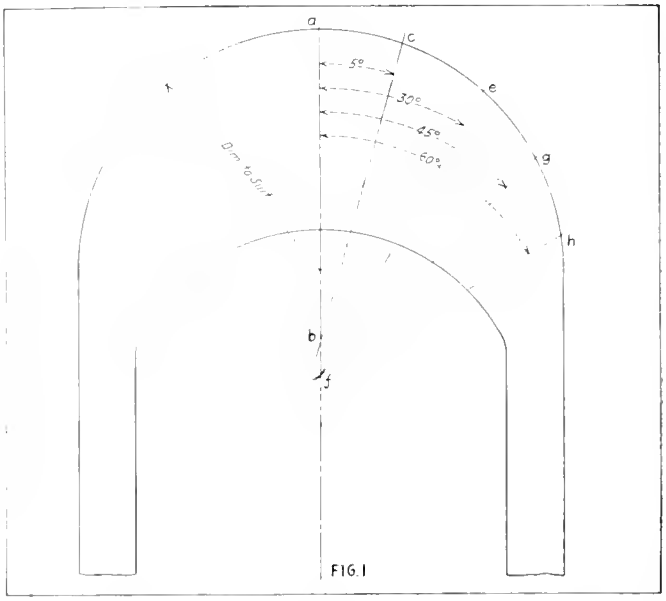


Fig. 1.—Example Demonstrating Method of Determining Stays for Wrapper Sheet

In Par. 212 (a) the first requirement given, is to ascertain the allowable working pressure between the stays, that is the net plate section, in accordance with Par. 180. The formula is as follows:

$$\frac{TS \times t \times E}{R \times FS}$$

in which TS = tensile strength of plate in pounds per square inch.
t = minimum thickness of plate, inches.
E = Efficiency of longitudinal joint or net section of plate between stay holes.
R = inside radius of wrapper sheet.
FS = factor of safety, equals 5 for new constructions.

The value of TS = 55,000 pounds per square inch.
The efficiency of the net plate section =

$$\frac{7.07 - .875}{7.07} = 87.7 \text{ percent.}$$

Substitute these values and those of the example, then

$$\frac{55{,}000 \times \frac{1}{2} \times 0.877}{36 \times 5} = 133.9 \text{ pounds per square inch}$$

maximum allowable working pressure without allowing for the holding power of the stays.

To this pressure is to be added the pressure obtained by the formula Par. 199, in which, use 70 for the value of C. The formula is as follows:

$$P = C \times \frac{t^2}{p^2}$$

in which; P = allowable working pressure pounds per square inch.
t = thickness of plate in *sixteenths*.
p = maximum pitch between stays, inches.

The value of $t = 8$.
The value of $p = 7.07$ inches.
Substitute these values in the formula.

$$\text{Then, } P = 70 \frac{8 \times 8}{7.07 \times 7.07} = 89.6 \text{ pounds nearly.}$$

The pressure 89.6 is to be added to that found for the net plate section, then in accordance with the first condition of Par. 212 (a). The allowable pressure equals 133.9 + 89.6 = 223.5 pounds per square inch.

For the second condition the pressure is based on the sum of the allowable pressure on the net plate section as already determined and that allowed on the stays.

The safe load allowed on a 7/8 inch stay using an allowable stress of 7,500 pounds per square inch, as given in Table 5, equals
$0.7854 \times 0.875 \times 0.875 \times 7{,}500 = 4{,}509.75$ pounds.

The area supported by the stay is, $7.07 \times 7.07 = 49.9$, say 50 square inches.

Then, $4{,}509.75 \div 50 = 90.19$ pounds per square inch.

$133.9 + 90.19 = 224.09$ pounds per square inch allowable working pressure in accordance with the second condition.

The next requirement is to determine the pressure by the formula, in 212 (b),

$$P = \frac{11{,}000t \times E}{R - s\Sigma \sin \alpha}$$

in which, P = allowable working pressure pounds per square inch.
α = angle any crown stay makes with the vertical axis of the boiler.
Σ = summated value of sin for all crown stays considered in one transverse plane and on one side of the vertical axis of boiler.
s = transverse spacing of crown stays in crown sheet inches.
E = minimum efficiency of wrapper sheet through joints or stay holes.
t = thickness of wrapper sheet, inches.
R = radius of wrapper sheet, inches.
11,000 = allowable stress, pounds per square inch.

In the application of this formula ascertain the sin of the respective angles, *abc*, *afc*, *afg*, *afh*, and add them together.

$$\begin{aligned} \text{Thus, } \sin 15^\circ &= 0.2588 \\ \sin 30^\circ &= 0.5000 \\ \sin 45^\circ &= 0.7071 \\ \sin 60^\circ &= 0.8660 \\ \hline & \ 2.3319 \end{aligned}$$

The values to be substituted in the formula are as follows: $t = 1/2$, $E = 0.877$, $R = 36$, $S = 5$, an assumed pitch for the crown stays, $\Sigma = 2.3319$, $\sin 15^\circ = 0.2558$.

$$\text{Then, } P = \frac{11{,}000 \times 1/2 \times 0.877}{36 - 5 \times 2.3319} = 198 \text{ pounds per}$$

square inch.

The allowable pressure is the smallest value as found in accordance with the three methods given, and in this case is 198 pounds per square inch.

Horizontal Return Tubular Boiler Design

Q.—We are contemplating building for stock some 10, 25, 50 and possibly 75 horsepower return tubular and vertical leg boilers, and we would be pleased if you could furnish us with diagrams and information on head bracing and flue spacing, together with a few cuts showing boiler head design for shell diameters 48 inch and up showing number of tube holes and size of same. Our desire is to manufacture standard boilers of a good design, and information that you might furnish us along these lines would assist us very much. Thanking you for any information you might send us in this connection, we beg to remain.—J. J. McL.

A.—The data you request cover a large amount of designing, typical constructions of both types of boilers that make

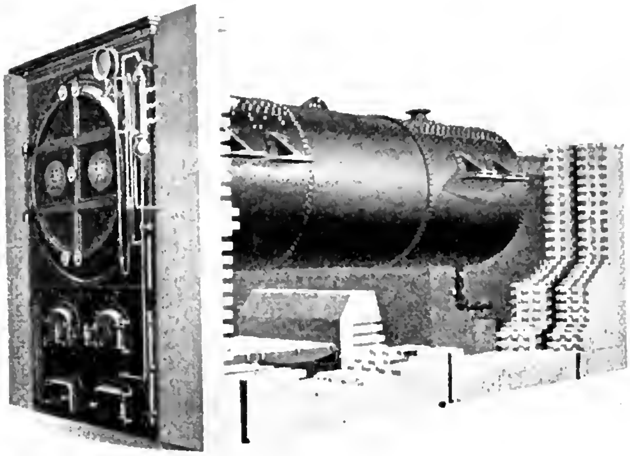


Fig. 1.—Flush Front Horizontal Return Tubular Boiler

it practically impossible to cover fully in these columns. We will endeavor, however, to give assistance that will show some of the features in the proportioning of horizontal return tubular boilers.

Boilers of this type are made in two types, the flush front and extended front types illustrated respectively in Figs. 1

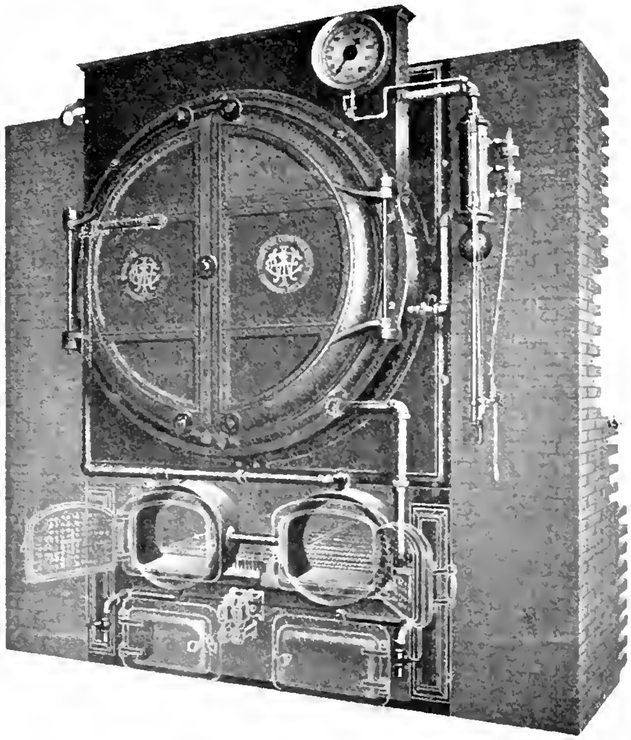


Fig. 2.—Extended Front Horizontal Return Tubular Boiler in Setting with Patented Firedoor Protector

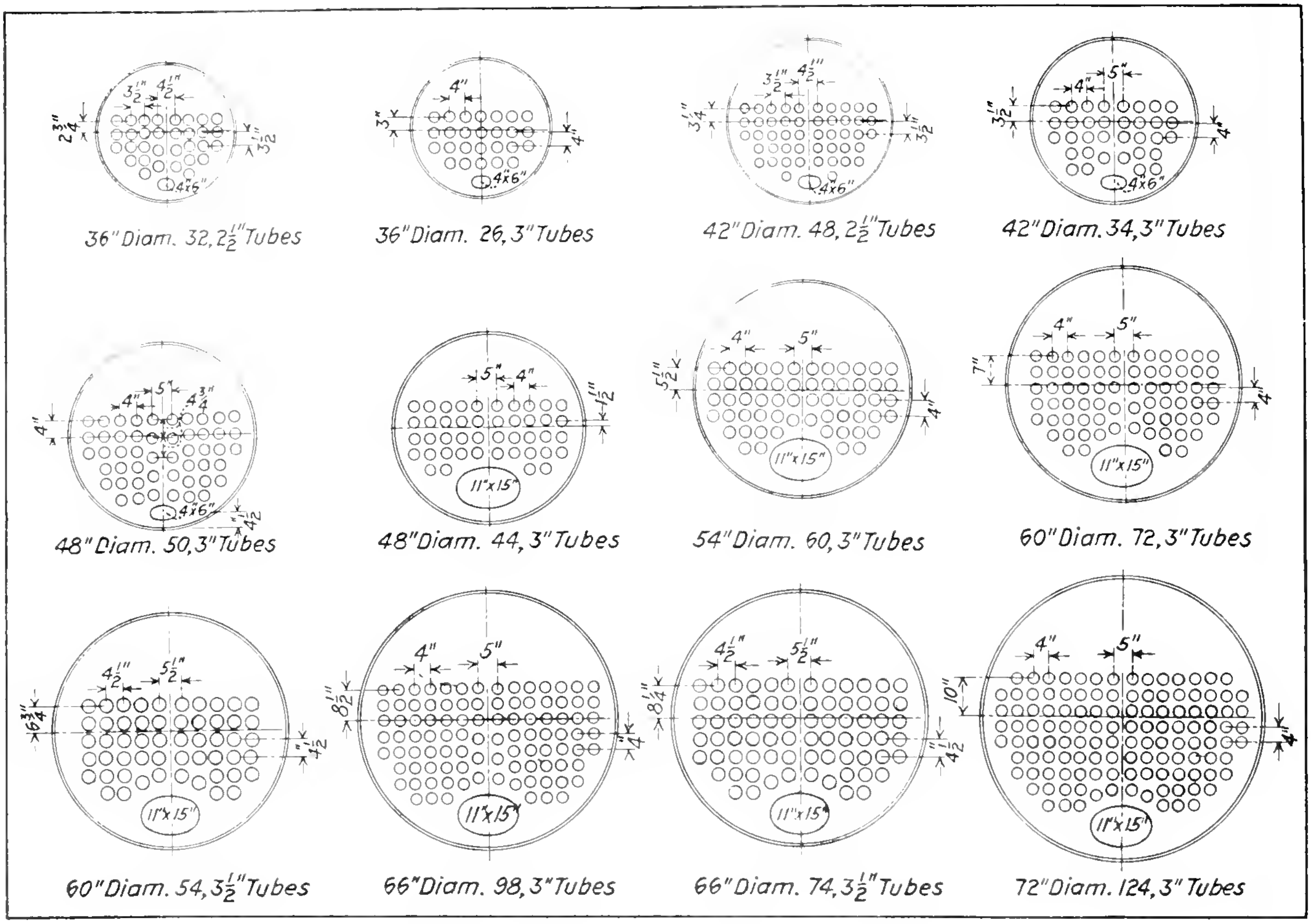


Fig. 3.—General Layout of Tubes for Various Size Heads

and 2. The terms "flush" and "extended" refer to the manner of setting the boilers.

The design of such boilers involves the use of the rules of the A.S.M.E. Boiler Code, now generally used in the United States. In the proportioning of a boiler for a given horsepower manufacturers have adopted 10 square feet of heating surface as required to develop a boiler horsepower. On this basis, calculations are made for the diameter of boiler, size of grate and other details as given for some of the details in Table I.

Fig. 3 shows a general layout of tubes for a number of standard size heads. The staying of the segments above and below the tubes should be made in accordance with the rules given in Par. 213 to 229 of the A.S.M.E. Code. For the smaller heads of 30, 34 and 36 inches in diameter the staying of the upper segment may be made as shown in Fig. 4, in which angles *a* or tee irons may be used.

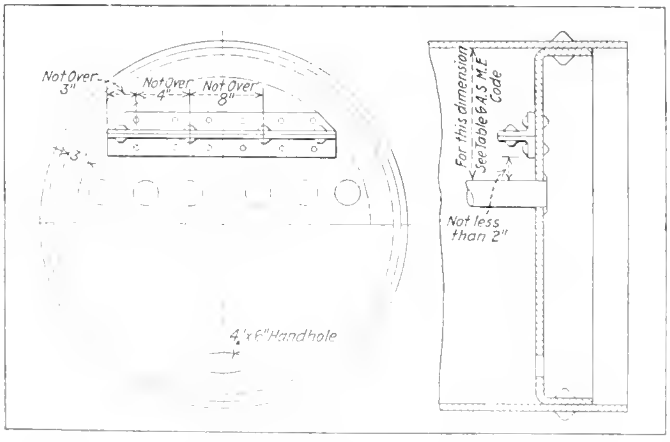


Fig. 4.—Showing A. S. M. E. Staying Requirements for Boiler Heads 30", 34" and 36" in Diameter

For further information on the design of horizontal return tubular boilers and their layout refer to the book entitled "Laying Out for Boiler Makers" published by THE BOILER MAKER.

TABLE

Size and Horse-Power Rating, Horizontal Return Tubular Boilers

*Horse-Power	Diameter, Inches	Length, Inches Ft.	Length, Inches In	Tubes Number	Tubes Diameter, Inches	Tubes Length	*Boiler Heating Surface, sq. ft.	Size of steam nozzle. Dia. In.	Dia. of safety valve No.	Dia. of safety valve Dia	Dia. of feed pipe. Inches	Dia of blow-off. Inches
20	36	8	11	32	2½	8	198	4	1	1½	1	2
25	36	10	11	26	3	10	245	4	1	1½	1	2
35	42	11	0	48	2½	10	352	4	1	2	1	2
40	42	14	0	34	3	13	404	4	1	2	1	2
53	48	13	2	50	3	12	526	4	2	1½	1	2
58	48	16	3	44	3	15	582	4	2	2	1	2
78	54	16	3	60	3	15	777	5	2	2	1¼	2
88	60	17	5	54	3½	16	883	5	2	2½	1½	2
99	60	17	5	72	3	16	985	5	2	2½	1½	2
117	66	17	6	74	3½	16	1,172	6	2	3	1½	2
130	66	17	6	98	3	16	1.304	6	2	3	1½	2
146	66	19	6	98	3	18	1,463	6	2	3	1½	2
156	72	19	7	78	4	18	1,562	6	2	3	1½	2½
167	72	19	7	96	3½	18	1,674	6	2	3	1½	2½
183	72	19	7	124	3	18	1,827	6	2	3½	1½	2½
190	78	19	8	96	4	18	1,902	6	2	3½	2	2½
211	78	19	8	144	3	18	2,107	6	2	3½	2	2½
243	84	19	10	142	3½	18	2,425	7	2	3½	2	2½
260	84	19	10	180	3	18	2,598	7	2	4	2	2½
285	90	19	11	168	3½	18	2,848	7	2	4	2	2½
300	90	21	11	140	4	20	3,008	7	2	4½	2	2½
338	96	22	0	158	4	20	3,384	7	2	4½	2½	2½
355	96	22	0	190	3½	20	3.552	7	2	4½	2½	2½
391	96	22	0	248	3	20	3,913	7	2	5	2½	2½

*Horsepower based on 10 sq. ft. of heating surface.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Largest Low Pressure Welded Boiler in the Country

On account of the increasingly large use of welding both by means of the oxy-acetylene and electric process for boiler repairs and construction, I enclose two illustrations of the largest all welded heating boiler recently built in the United States, together with details regarding the size, etc., in which no doubt the many readers of The Boiler Maker and engineering profession in general will be interested.

This boiler was recently constructed by the General Boilers Company of Waukegan, Illinois, who manufacture the Pacific low pressure heating boiler exclusively, in all sizes, from the smallest, 22 inches in diameter for residences, up to and including those like the one illustrated, 84 inches in diameter and capable of handling a load of 35,000 square feet of steam radiation.

Great Demand for this Type Boiler

That these boilers are giving satisfaction and proving more economical both from a construction and also an operation stand-point than the riveted or cast iron construction, is evidenced by the unusual demand during the past year for them from practically every state in the union and Alaska. From a safety stand-point these boilers are proving very satisfactory as the writer has kept personal records of nearly 2,000 of these electric welded boilers and as yet has not heard or known of an explosion or accident to any of them. This enviable record is one the manufacturers expect and hope to maintain. All boilers are being built to the requirements of the new A.S.M.E. Heating Boiler Code, besides being under the constant inspection and supervision of the Maryland Casualty Company inspector, who inspects and insures the entire production of this plant.

A description of the boiler illustrated is as follows: Built by General Boilers Co., Waukegan, Illinois, July, 1923, Catalog No. 229C—Serial No. 2098 Maryland Casualty Co., No. 1557 for Higginbotham Bailey Logan Company of Dallas, Texas—Total weight of boiler complete 30,000 pounds. Capacity of steam radiation 35,000 square feet, allowable working pressure 15 pounds. Shell, 84 inches in diameter, 14 feet 6½ inches long, 7/16 inch thick with ½ inch heads. Plates and heads being of Otis Steel Company 45,000 pound tensile strength flange quality steel.

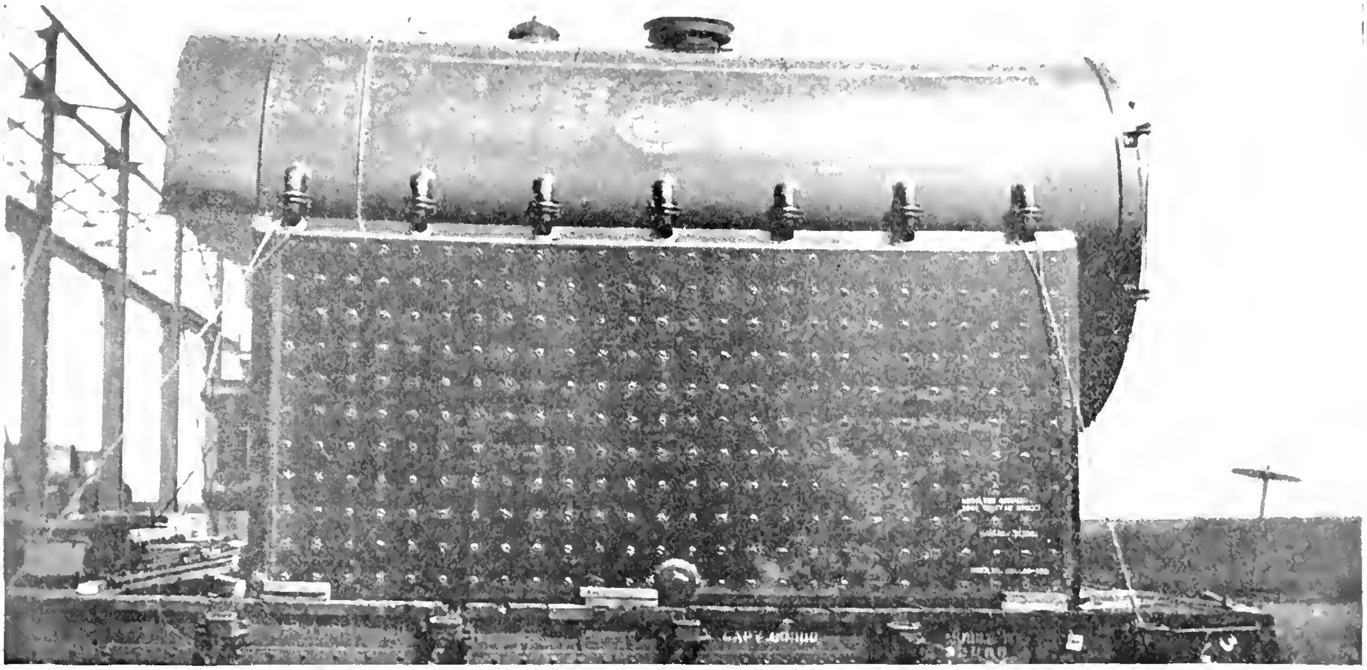


Fig. 1.—Boiler Claimed to Be Largest All Welded Low Pressure Boiler in America

It has 68-4 inch tubes 13 feet long, and 68-4 inch tubes, 11 feet 6 inches long of number 10 gage thickness, the tubes being rolled, and beaded on both ends in the usual manner.

Longitudinal Seam Reinforcement

The longitudinal seam being something out of the ordinary a description of same together with illustration Fig. 2 will probably make clear the construction of it. The shell plates were carefully planed and beveled and then butt welded, after which ribs 12 inches and 18 inches long, the same thickness of the shell plate, 7/16 inch, were cut to the inner curvature of the shell and bevelled on the curved edge. These ribs were then set edgewise on 6 inch centers across the shell seam and welded the full length on both sides of

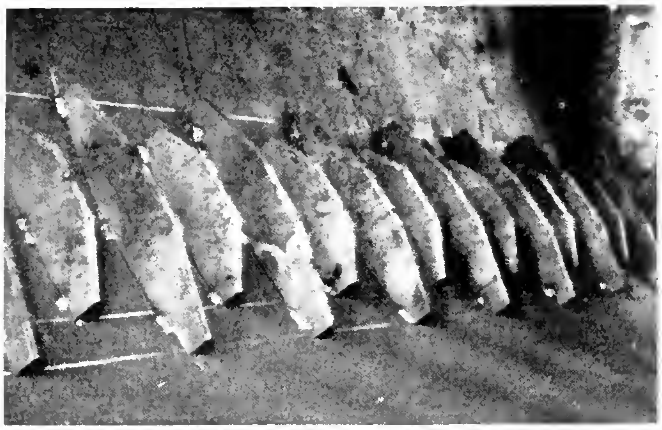


Fig. 2.—Longitudinal Butt Joint Reinforcements for 84-inch Boiler

the rib, to divide up the stress the ribs were used alternately, first an 18-inch rib then a 12-inch rib and then an 18-inch and continued in this manner the full length of the seam, making a practically indestructible joint and considerably stronger than the original plate. The steam outlet on this boiler is 12 inches in diameter and 2-4 inch diameter safety valve outlets: All fittings to the shell are welded inside and out.

The firebox is constructed of 5/16 inch Illinois Steel Company 45,000 tensile strength plates flange quality steel, and is 95 inches wide, 162½ inches long, with staybolts 6½ inches by 7 inches pitch, ⅞ inch diameter, a solid smooth bolt being used, all bolt holes carefully countersunk nearly the thickness of the sheet before being welded.

Tested for One Hundred Pounds

The shell and also the firebox were carefully tested separately to 100 pound hydrostatic pressure showing no weakness or distress after which the shell and firebox were assembled as shown in view number one and again tested to 100 pound hydrostatic pressure with the same result.

All seams, staybolts, braces, fittings and connections were welded by the electric process using standard equipment and metallic electrodes; which process has been found after several years trial most satisfactory on this class of work.

Waukegan, Ill. J. H. Petherick, Jr., Inspector.

Don't Establish Precedents

The slogan of one of the foremost financiers in New York City is "Never Establish a Precedent."

A number of years ago this seemed like a sort of foolish slogan to the writer, but as the years roll along I am beginning to agree with the financier. When something new comes along it may be necessary to establish a precedent but really new occurrences are exceedingly rare these days.

For example, if you are a specialist in your occupation, if you have spent a great many years making yourself efficient at it and know how to do things more economically than the other fellow, you surely have a right to *charge* for your knowledge and the person seeking knowledge should expect to *pay* in the same way that we all expect to pay for advice when we visit a doctor or a lawyer. Doctors and lawyers don't establish precedents by giving *free* advice the first call. They usually charge *more* for the first visit and less for succeeding visits.

I am inspired to write this because of the numerous mistakes I have made personally thereby not only weakening my own position but harming the business of other consultants. In one recent instance a stranger called and asked for my opinion relating to a "small matter" involving power transmission. I advised him what to do and how to do it, and showed him where he could save $300 by *not* doing what he intended to do.

A $30 fee would have been only 10 percent of the $300 and I would have been entitled to that much. Our conversation lasted only 15 minutes or so, that is true, but it took years for me to gather the knowledge and experience that enabled me to give him an answer so quickly and with such positiveness.

Did I charge $30? I did *not*. The stranger asked, "Will there be a charge for this little talk?" with emphasis on the word "little," and his actions which were louder than his words indicated plainly that he was certain that there would be no charge. I chicken-heartedly said, "No. No. charge. You're welcome." The stranger thanked me cordially and walked out.

About a week later he came in again and wanted to "get a certain little thing straight," consuming another 10 or 15 minutes of my time.

I told him what he wanted to know to the best of my ability. He "thanked" me, as per the first performance, but on his way out I called to him and explained that I would have to make a small charge this time as I am in the consulting business to make a living and the only way in which I can make a living at it is to charge money for my services.

The fellow paid the $5, but, do you know, he acted as though he was parting with an entire year's salary. I doubt if he will ever come again because he probably thinks that I gave him free advice the first time so that I could "sting" him the second time. Had I charged $30 the first time I am certain that he would have respected me for it. He would have expected to pay the second time. The chances are that now he has very little respect, if any at all, and what is more he is probably going around telling his friends that I am a "grafter" and that if they want to get "stung" to go to Mr. Schaphorst.

Don't you think the financier is right? "Never establish a precedent."

Newark, N. J. W. F. Schaphorst.

TRADE PUBLICATIONS

CO_2 Recorder Accessories.—Three devices, developed to prevent fouling and corrosion of CO_2 equipment and the tubing which conveys the gas sample to the instrument continuously, are described and illustrated in an 8-page bulletin, No. 166-A, which has recently been issued by the Uehling Instrument Company, Paterson, N. J.

Tool Grinding Machines.—An instructive 20-page bulletin (No. 102) has recently been issued by the Greenfield Tap & Die Corporation, Greenfield, Mass. This bulletin describes the principal features, giving specifications and details, of the plain cutter and reamer and universal grinding machines made by the Greenfield Tap & Die Corporation. A complete list of the sizes, shapes and grades of grinding wheels is included in the bulletin.

Locomotive and Other Cranes.—The Industrial Works, Bay City, Mich., has issued an elaborate catalogue of its products commemorating the completion of a half-century of its existence. Sections are devoted to (1) locomotive cranes of rail, traction and crawling tractor types, and large, wharf and gantry cranes; (2) crane accessories, such as clam shell buckets, magnets and drag lines; (3) wrecking cranes ranging from 75 tons to 200 tons capacities; (4) special railway equipment, such as pillar and transfer cranes, portable rail saws and transfer tables; (5) pile drivers, pile hammers, etc., and (6) facilities for foreign service.

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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

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States

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California	New York	Rhode Island
Indiana	Ohio	Utah
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Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

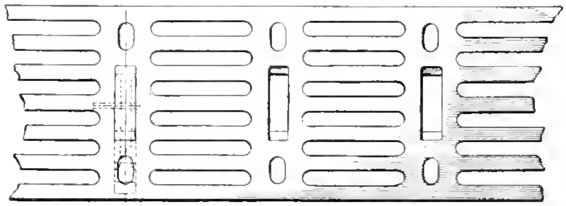
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,459,288. FIRE GRATE FOR LOCOMOTIVES. JAMES G. ELLIS, OF ST. LAMBERT, AND GEORGE WALTER MINGIE, OF MONTREAL, QUEBEC, CANADA.

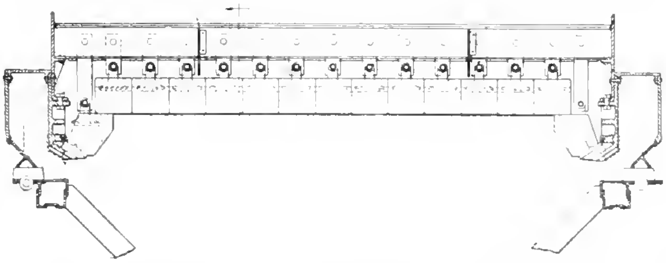
Claim 1.—A grate bar adapted to be shaken, provided with a plurality of spaced-apart identically formed holes extending therethrough from the top to



the bottom of the bar and tapering downward, said holes constituting draft openings and shaker arm receiving openings in combination with a shaker arm comprising a head portion fitting in one of said holes and a depending portion attached to said head portion and extending below the grate bar, said head portion being adapted to fit within any one of said holes. Eight claims.

1,463,240. SUSPENDED ARCH CONSTRUCTION FOR FURNACES. FRANK B. BIGELOW, OF DETROIT, MICHIGAN, ASSIGNOR TO MURPHY IRON WORKS, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

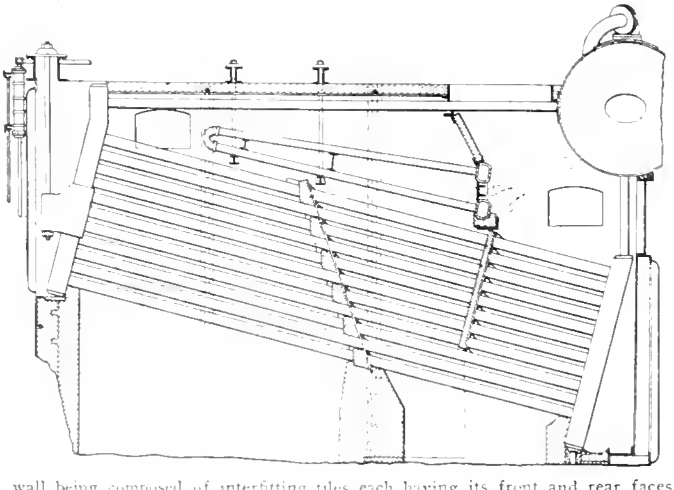
Claim.—In an arch-construction of the character described, the combination of a plurality of arch-bricks, a main supporting-structure, a hollow supporting-member slidably mounted on said structure, a furnace front-plate apertured



in registration with said member, the latter being adapted to receive outer air through said front-plate aperture and deliver it into the space above the arch, a plurality of hangers supporting said bricks individually from said member, a back wall for the space above the arch apertured in register with said member and removable means normally closing said back wall aperture, the construction permitting the removal of any hanger and its injured brick by shifting the member longitudinally sufficiently through one of said apertures to free the hanger of the injured brick therefrom and temporarily supporting the remainder of the bricks not sustained by the member in its new position by a follower introduced through the other aperture.

1,459,560. BAFFLE WALL FOR HORIZONTAL WATER-TUBE BOILERS. FREDERICK C. STIMMEL, OF CHATTANOOGA, TENNESSEE, ASSIGNOR TO THE CASEY-HEDGES CO., A CORPORATION OF OHIO

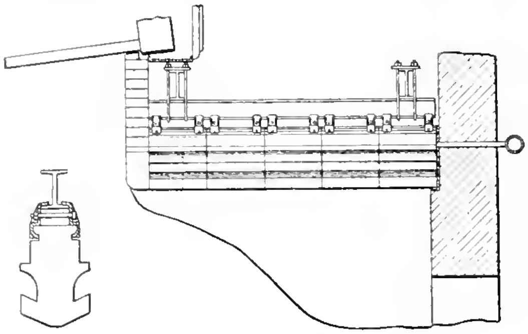
Claim 1.—A baffle wall, for horizontal water tube boilers, arranged transversely of the tubes and inclined forwardly for the purpose specified, said



wall being composed of interfitting tiles each having its front and rear faces inclined in a forward and upward direction, but at different angles, and the base of each tile being thicker than its upper edge. Twelve claims.

1,462,267. FURNACE ARCH. ROGER D. DE WOLF, OF ROCHESTER, NEW YORK.

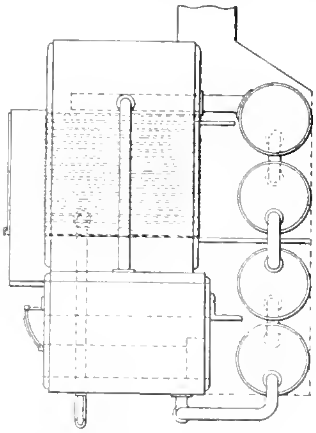
Claim 1.—A furnace arch comprising a plurality of supporting elements, a plurality of hanger bricks supported by each of said elements independently



of the other elements by means providing for the lowering and replacement of the bricks through the combustion chamber, and lining bricks carried by said hanger bricks to protect the latter and form a complete lining for said arch. Twenty claims.

1,462,763. STEAM BOILER. WAICHI NAKAGAWA, OF KITAKU, JAPAN.

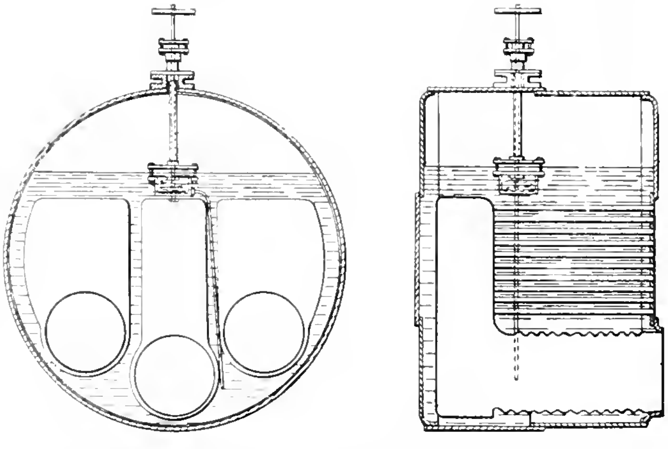
Claim 1.—A steam boiler comprising two lower cylindrical elements having each a furnace, an upper cylindrical element having a nest of fire tubes, a smoke box at the front end of the said elements interconnecting the space



between the three elements with the fire tube nest, a combustion chamber at the rear end of the said elements, a partition wall in the combustion chamber dividing it into an upper and a lower compartment in such a way that the lower compartment is in communication with the said space and the upper compartment with the rear end of the fire tube nest, drums in the two compartments interconnected in series and fluid connections between the end drums and the said elements respectively. Two claims.

1,464,225. BOILER PRIME PREVENTER. JOHN HENRY STOCKHOLDER, OF NEW ORLEANS, LOUISIANA.

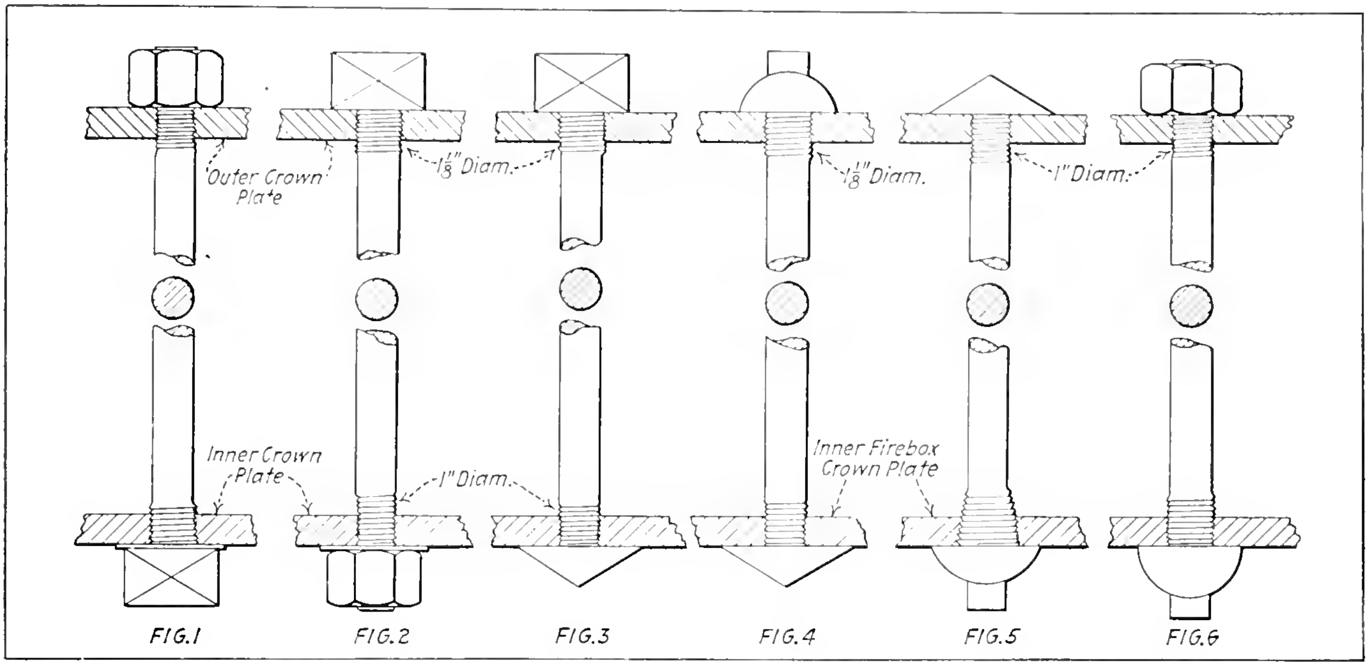
Claim.—The combination with a boiler having a feed pump in connection therewith for supplying the boiler with water, of a float controlled valve in connection with said boiler, apertured pipes connected to said valve and dis-



posed within the boiler, one of said pipes being disposed adjacent the water level, the other apertured pipe being disposed adjacent the bottom of the boiler, said float controlled valve forming means whereby the water within the boiler may be skimmed and the sediment in the bottom of the boiler removed, said float controlled valve being so constructed that when the water drops below normal level steam will pass through said valve to the feed pump for accelerating its action and when the water rises above normal level the valve will open a discharge pipe, thereby preventing priming of the boiler and at the same time admitting steam to the feed pump for feeding water to the boiler.

THE BOILER MAKER

NOVEMBER, 1923



Types of Direct Stays for Crown Sheets

Designing the Crown Sheets of Locomotive Boilers

Outline of British Methods of Staying Boilers Compared with American Practice

By A. Wrench

TWO types of crown stays are in use in Great Britain, namely, girder stays used with round topped outer covering plates, and direct stays used with Belpaire fireboxes. In America direct stays are used in conjunction with round topped outer firebox plates. Some years ago many locomotive engineers specified Belpaire fireboxes until at the present time many main line express locomotives are so fitted. It is claimed that the Belpaire form of construction gives a greater steam and water capacity where it is most required, and the use of the cumbersome yet flexible girder stays is dispensed with. The Belpaire form of construction introduces an additional flat surface, which is allowed to rise upward when the inner firebox first becomes heated.

Features of the Girder System

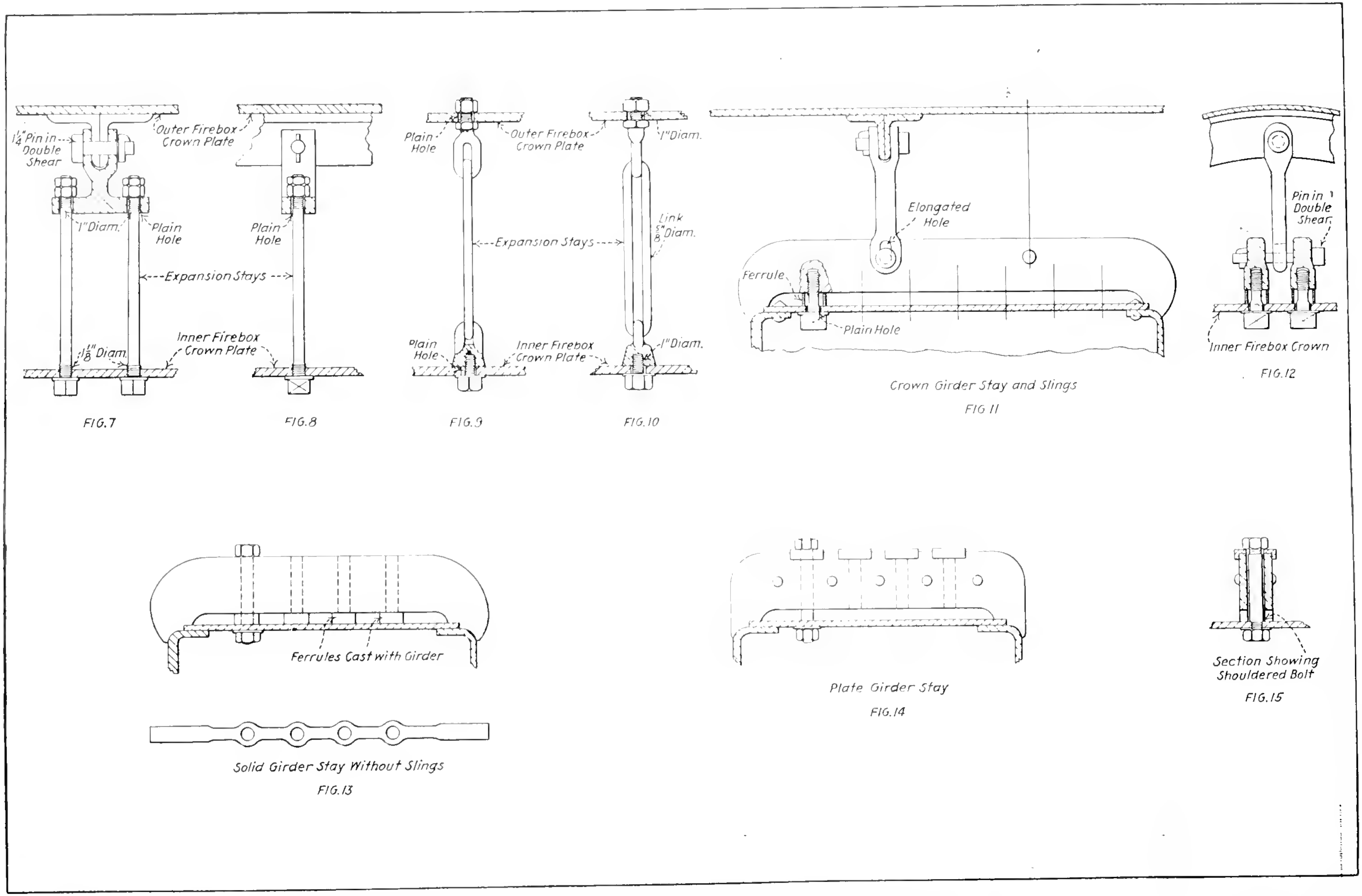
In the girder system the upward expansion of the inner firebox is accommodated by the girders being free to rise, the round top outer plate being rigid. To obtain a correct perspective of these movements one must follow the movements of a firebox from the time the fire is started when the boiler is cold until steam is raised. Directly the inner firebox becomes warm the plates and tubes expand and stresses occur in the plates and flanges.

The inner firebox, being rigid at the foundation, rises, and the outer firebox being still cold remains stationary. The outer crownplates of Belpaire fireboxes will be stressed during this period owing to the direct stays connecting the two crown plates, the stays being in compression and subject to bending stress. As steam is raised the outer firebox crown becomes heated and expands, and the pressure of steam bears on the two surfaces. This tends to equalize the stresses due to the first expansion and the strain on the stays becomes tensile.

The stress of expansion of the crown plate is greatest near the tubeplate and firedoor plate where the presence of the shell and riveted joint of the firedoor plate make these places rigid. It is usual for engineers to allow for this expansion by fitting three or four rows of expansion stays to allow these parts to rise.

Types of Stays Used

Two types of expansion stays are shown in Figs. 7-8 and 9-10. Sometimes cross girders are fitted at these parts, where



Expansion Stays and Special British Type Stays

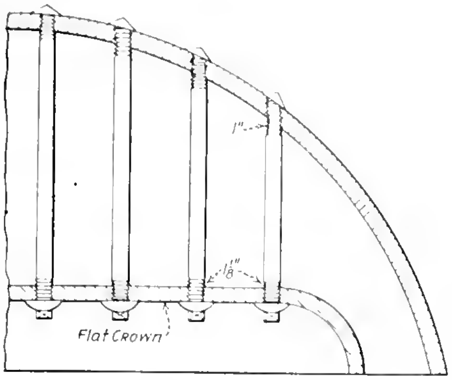


FIG.16-Direct Stays Applied To Flat Topped Inner Firebox

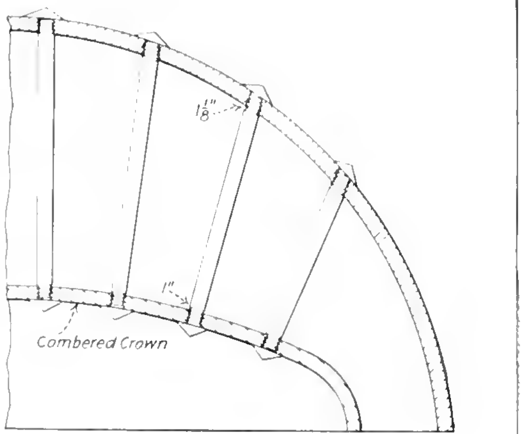


FIG.17-Direct Stays Used In Conjunction With Cambered Inner Firebox Crown Plate

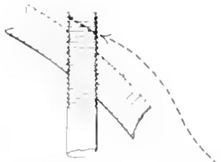


FIG.18-Enlarged View Showing Direct Stay Passing Through Outer Firebox Crown, and Portion To Be Chipped Before Riveting

FIG.19-Tool For Inserting Crown Stays Which Are To Be Riveted At Both Ends

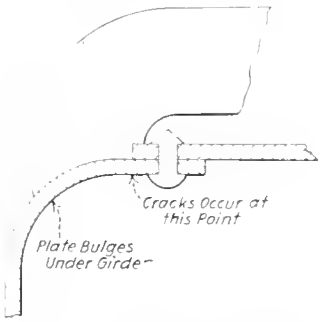


FIG.20-Radius of Flange of Firehole Plate Too Large

Application of Stays to Crown Sheets of Different Kinds

the radius of the side flanges will allow. In practice the free movement allowed by these expansion stays causes the saddle plate connecting the wrapper plate to the barrel to crack on the inside at the top as shown in Fig. 26.

When a boiler fitted with girder stays is subjected to strains of expansion during the period of steam raising, free movement of the inner firebox in an upward direction is allowed for, without the outer firebox crown, which is semi-circular being stressed. The downward thrust of the pressure of steam and the expansion of the outer crown bring the girders and slings into stress. The girders transmit the pressure to the end plates on which they rest. Any deflection of the girders is taken up by the sling stays connected to the outer crown by angles. These sling stays have an elongated hole at one end to allow the girders to rise. It is usual to fit the toes of the girders onto the tubeplate and firedoor plate flanges and it is necessary to make these flanges of small radius to enable the plates to take up the compressive stress, without distortion or cracking of the flanges.

Inner firebox crown plates of fireboxes fitted with girder stays are frequently found to be out of level. This generally occurs where the girders are secured together in pairs which allows the two outside girders to tilt when the firebox side plates expand. This distortion is avoided when all the girders are braced together. The flanges of the crown plate should be of ample radius to accommodate expansion or the plates will crack in this neighborhood after a short term of service.

Comparison of Belpaire and Wagon Top Fireboxes

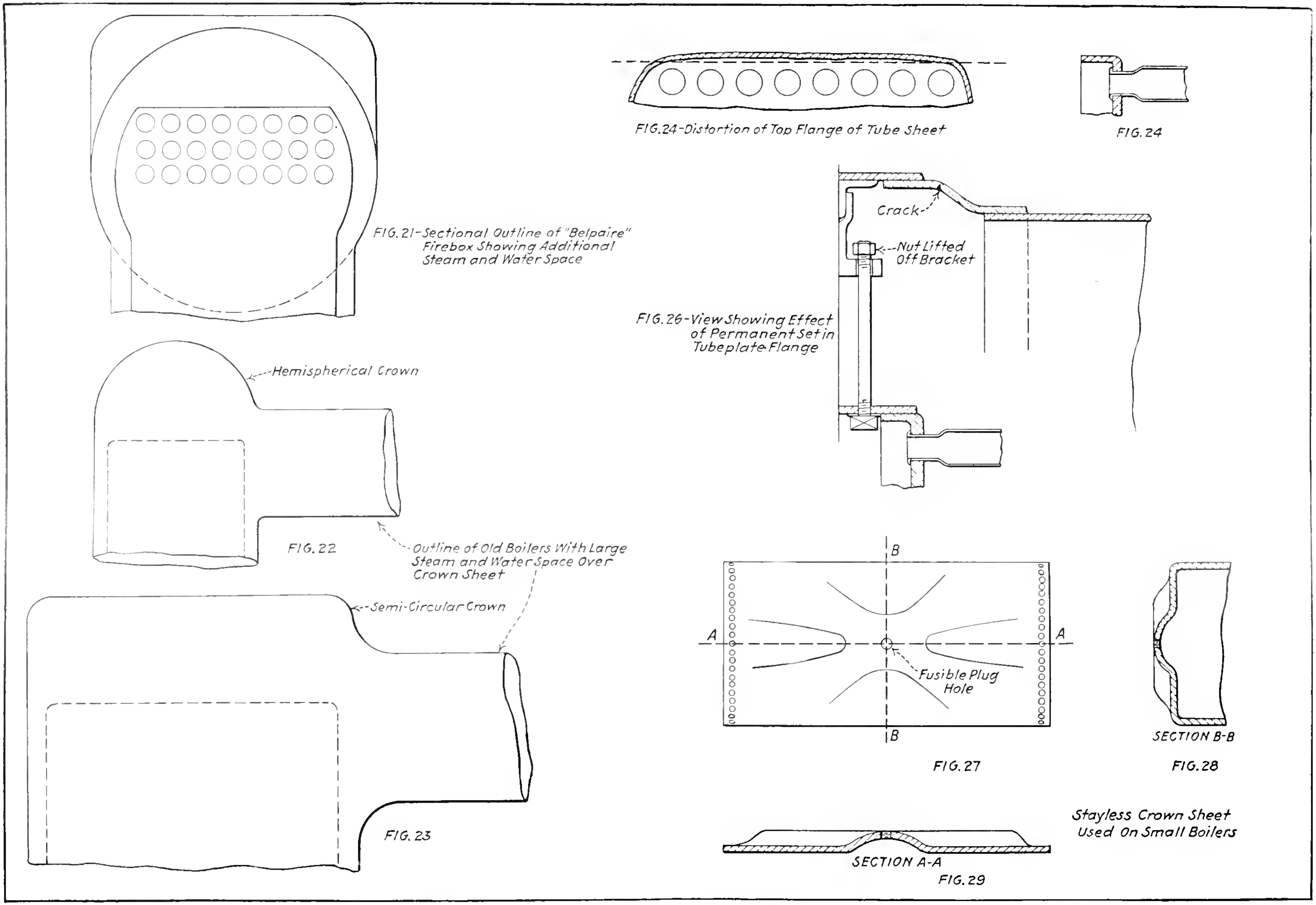
From the foregoing it will be seen that the principal differences between the Belpaire construction and the round or wagon top is: Greater steam and water capacity over the crown, free circulation of water by use of direct stays, absence of compressive stress on the firebox tube and firedoor plates, easy removal of sediment, utilization of flat outer crown to accommodate expansion and breathing of inner firebox. The principal advantage of the round topped firebox is the flexibility afforded by the girder stays and the semi-circular construction of the outer crown plate which does not require staying.

It should be remembered that while the Belpaire firebox allows for a large steam and water space over the crown plate the volume of steam generated has to pass along a space which is a circular segment to get to the dome. Ample space for water and steam is found in old locomotive boilers without use of a flat outer crown, Figs. 22 and 23. It would appear to be inadvisable to use direct stays in conjunction with a round outer crown as the upward expansion of the inner plates would not be accommodated by any flexibility of the outer crown as in the case of the Belpaire. Also when using a flat inner crown plate direct stays will not be radial to the plates through which they pass.

American Practice

In America direct stays are frequently used for this type of firebox, but a cambered inner firebox is used to which the stays are radial. The surplus threads are chipped on the outside to enable them to be riveted correctly. Frequently in watertube boilers the generating tubes are not radial to the drums, and if these can be fitted effectively stays which are not radial to the plates can be used.

During the war the writer had to periodically inspect the boilers of 326 locomotives built by the Baldwin Locomotive Company and 98 locomotives built by the American Locomotive Company which were fitted with direct stays. No crown plate trouble was experienced on these boilers except when the boilers had been short of water, when, as a rule, several crown stays would leak which were easily put right by prossering.



Special Boilers and Methods of Taking Stresses in Crown Sheets

Alternative Methods of Construction

If upward expansion must be allowed for in round topped fireboxes, some form of direct expansion stay can be used without resorting to Belpaire construction or girder stays. A cambered inner firebox crown is good practice as the efficient heating surface is increased, and in case of the boiler being short of water only a narrow strip of crown is uncovered before the fusible metal blows out of the plug. Repairs to crown plates are chiefly necessitated by fusible plug failures, accumulations of scale and oil on the crown, etc.; therefore, it is necessary to provide for accessibility of repair and cleaning. The heads of staybolts connecting the crown to girders should be on the firebox side and not in the water space so that they can be removed easily. Where direct stays are used the nuts should not be placed on the outside where they are only accessible by removing lagging.

Expansion stays in Belpaire fireboxes should be fitted so that the joints can be re-made if necessary from the firebox side. This can be done where stays as in Figs. 9 and 10 are used, but tubes have to be removed to repair stays similar to those shown in Figs. 7 and 8.

Danger from Clinkers

The heads of crown staybolts are frequently made of large section to which clinkers adhere covering up much of the crown heating surface. The writer has recently removed some which weigh 1/2 pound and are 4 3/8 inches long, 2 1/4 inches wide. The whole covered up approximately 6 square feet of heating surface. Direct stays could be riveted on the firebox as this is the practice with side plate stays whether steel or copper. The heads would then lie flat against the crown and clinkers would not adhere. In case of leakage they could be calked. Several types of direct stays are shown in Figs. 1 to 6.

The solid girder is superior to the plate girder as it is cheaper to construct and allows the bolts connecting it to the crown to be easily renewed. Ferrules should not be separate from the girder but cast as a part of it. This method of construction facilities the removal and refitting of the girders whenever this is necessary to level the crown plate.

The dished or flanged crown shown in Fig. 27 is only suitable where small fireboxes of steel are used, such as those used in road rollers or small stationary boilers of the locomotive type. It will be noticed that the fusible plug is situated in the highest point which admits of only a small portion of the crown becoming bare before the attendant is warned of danger.

Breakage of Staybolts

Locomotive engineers differ in opinion as to the advisability of screwing crown staybolts into the inner firebox crown or using a plain hole. In case of a bolt breaking which is screwed into the crown no indication is given and the crown plate will bulge. On the other hand, a staybolt which is not screwed into the crown will blow out if broken and thus prevent further damage by indicating the failure. Crown staybolts usually break just above the crown where the threads commence and reference to Figs. 7, 9 and 11 will show what will happen in case of breakage in the respective cases.

Where girder stays are used the radius of the top firehole plate flange is usually made too large, which results in cracking and distortion at the points shown in Fig. 20. The side flanges of this plate should be large, but should be tapered off towards the top to enable the girders to effectively transmit the downward pressure on the vertical plate and not the flange. The same rule applies also to the tubeplate flanges, but these are usually made of small radius to allow the maximum number of tubes to be used. Frequently, too, top flanges of tubeplates are found to be out of true. This is caused by expanding flues and by the expansion stays allowing this part to rise during steam raising, resulting eventually in a permanent set. The nuts of the expansion stays under these conditions will be lifted off the brackets and will allow excessive breathing of the outer crown which will cause the plate to crack as indicated in Fig. 26. The flues will also leak, especially in the top rows. These nuts should be refitted to the brackets whenever the boiler is accessible internally.

While it is agreed that girder stays should be replaced by some form of expansion stays, boiler experts are reluctant to substitute a flat surface for a semi-circular one, and the writer's opinion is that the days of the round topped firebox are by no means over.

The following table shows the number of Belpaire and round top fireboxes in use on British railways, and will also show the difference of opinion among locomotive engineers regarding this important feature of locomotive firebox construction.

Railway	Great Western	Great Central	North Eastern	Lancashire & Yorkshire	Great Eastern	London & North Western
Engines fitted with Round top fireboxes	516	84	2,014	1,010	1,002	3,170
Engines fitted with Belpaire fireboxes	2,938	1,263	2	665	341	177

Power Exposition to Be Held in New York

The National Exposition of Power and Mechanical Engineering, to be held at the Grand Central Palace, New York, from Monday, December 3, through Saturday, December 8, is planned in cooperation with the national societies interested in the economy of fuel and in the production and use of power. The exposition will parallel the annual meeting of The American Society of Mechanical Engineers, which will be held at the Engineering Societies Building, 29 West 39th street, the first four days of the week. To avoid conflict between the two events, the sessions of interest to those who will attend the Power Exposition have been set for the mornings of the meeting; and the exposition will not open until one o'clock each day. The parallel arrangement will give engineers the desired opportunity to enjoy both events to the greatest possible degree.

The Power Test Codes Committee of the Society will hold a public hearing on the Code for Stationary Steam Generating Units and the Code for Locomotives. There will be an open meeting at which the report of the Fluid Meters Committee will be discussed. Progress in the program of society research and steam tables will also be treated at this meeting.

Further the A. S. M. E. Professional Divisions on Aeronautics, Machine Shop Practice, Management, Ordnance, and Forest Products will hold sessions of general interest to the engineering profession.

The Power Exposition offers a remarkable opportunity for the operating man to become acquainted with the latest devices in his field. This opportunity will be seized by the National Association of Stationary Engineers, the New York Building Owners and Managers Association, the New York Building Superintendents' Association, the Blue Room Engineering Society and the Ocean Associations of Marine Engineers who will attend the exposition in groups.

The monthly report to the President on the condition of railroad equipment sent in by the Interstate Commerce Commission shows that in September 5,262 locomotives were inspected by the Bureau of Locomotive Inspection, of which 47.6 per cent. were found defective, and 422 were ordered out of service. This percentage is less than for any month since July, 1922.

Welding by Means of the Electric Arc Process*

A Comparison of the Costs of the Different Welding Processes as Applied to Railroad Shops

THIS report deals principally with the economic status of arc welding and is intended to assist members of this association in arriving at relative costs of electric arc welding and other processes, particularly that of oxy-acetylene.

Welding operations, regardless of the process used, are merely applications of heat in proper form to the metals to be welded. The economics of welding, therefore, is largely, if not entirely, a matter of the economics of heat production and utilization. In the long run, the cost at which heat may be produced, suitable for welding operations, determines the process which costs the least to use; and, as long as economic laws apply to railroad shops, the process which will supersede all others is the one which gets the desired results at the lowest cost of producing the heat.

The issue today is, principally, between the heat produced by the oxy-acetylene flame and the heat produced by the electric arc. The field of forge welding is such as to eliminate the process from competition with the other two. Except for very heavy parts, Thermit welding involves an expense for its application, as well as for heat production, which, relative to the gas and electric welding processes, is so high as to practically eliminate it from the field in railroad shops.

The cost of producing heat depends, therefore, to a considerable extent, upon how directly the heat is produced. Fig. 1 shows graphically the steps which are intermediate between the production and utilization of the heat in a railroad shop. It is to be observed that the source of heat, whether the electric arc process or the gas process is used, is electric power. In the manufacture of oxygen, whether it be by the air reduction process or by the electrolytic process, electric power is the energy used to make the oxygen. This oxygen must then be compresesd in the tanks and the tanks transported to the store department. The store department delivers them to the manifold room, and the oxygen is delivered to the point at which it is used through a piping system. The manufacturer of the oxygen stands leakage up to the point at which the tanks are received by the store department. The leakage of the piping system, through which the oxygen is distributed to the points at which it is to be used, is paid by the railroad. Owing to the fact that oil cannot be used in the packing of the valves on the oxygen lines, the leakage of oxygen in the piping system amounts to a considerable figure.

The carbide, from which acetylene is made, is also a product of electric power. Carbide is made in an electric arc furnace. It must then be put in a metal container and transported to the user. It is then delivered to the acetylene generator room, where it is placed in the generator and combined with water to form acetylene gas. This gas is then delivered, through a piping system, to the point at which the heat is to be used.

The heat for electric arc welding is delivered direct from the power line to the arc welding machine, which merely converts the electrical energy into a form suitable for conversion by the electric arc into heat directly. It is obvious that the utilization of electric power for conversion directly into heat by the electric arc process involves a considerably less number of intermediate steps; and it could be assumed, without further investigation, that the cost of heat per B. T. U. is considerably less in the case of the electric arc process than the gas process.

Fig. 2 shows graphically the effectiveness with which the heat produced by the gas process and the electric arc process is used. In the former process, heat is produced in a neutral flame external to the metal to be heated. Due to the kinetic energy of the gases and their high temperature, a very large portion of the heat is carried off in hot gases and does no useful work. In the latter process, on the other hand, practically all of the heat is produced internal to the metals to be welded. Under normal circumstances, the largest amount of heat is produced in the heavier piece, and the balance of it is produced in the arc flame itself and the metal electrode. It is estimated that about 90 percent of the total amount of heat is produced either in the electrode or in the piece to be welded. There are no gases having kinetic energy —the heat losses are due to radiation and are relatively small.

Considering the cost of producing heat, without reference to the effectiveness of its use in the two processes, it is interesting to compare the cost of producing the amount of heat which is contained in the average pound of coal. Assuming that eleven thousand B.T.U. represents the average heat in a pound of coal, at $5.00 per ton delivered to the railroad power plant; and figuring oxygen at 1¾ cents per cubic foot; generator acetylene at 8/10 of a cent per cubic foot; and electric power, which the railroad makes itself, at 1 cent per kilowatt hour, with an overall efficiency of 50 per cent for the arc welding machine; the relative costs of the three sources of heat are as follows:

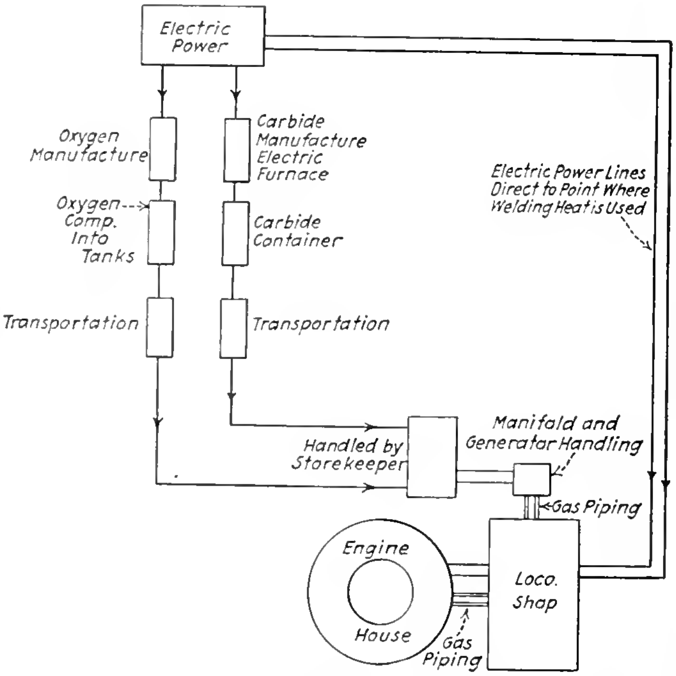


Fig. 1.—Comparison of Methods of Producing Heat for Welding

1 lb. coal	11,000 B.T.U. of Heat,		¼ cent
Oxy-acetylene	11,000	"	19.74 cents
Electric Arc	11,000	"	6.45 cents

*Report read at the fourteenth annual convention of the Association of Railway Electrical Engineers, November 6 to 9, at Chicago, Ill.

Fig. 3 shows the thermal economy of the electric arc process and the gas process graphically. These figures show the relative cost to produce heat, as well as the effectiveness with which it is used. The data given on the cost per hour of operation of the two processes does not include any element of the relative amount of work possible to produce.

Fig. 4 shows, in parallel columns, at the center of the table, cost of production of the electric arc process and that of the equivalent size torch tips, which would be used in place of each size arc welding electrode. It is assumed that the gas process would use manifold oxygen, 50 pounds pressure, at the manifold and generator acetylene.

Exclusive of cutting, the welding operations done in railroad shops today, with either the gas or the electric processes, 85 percent may be done as well, or better, with the electric arc than can be done with the gas process. The 15 percent exception includes all brazing operations and a majority of the cast iron welding. On a number of large railway systems of the country, from 60 percent to 80 percent of the operations which may be performed by the electric arc process are being done in this way; and on many of the other large systems, the replacement of gas welding by electric welding has preceded 25 percent to 50 percent of the possible replacement.

It appears that oxy-acetylene for welding will go the way of acetylene lighting for automobiles and acetylene lighting for houses and buildings. The present widespread use of acetylene flame for welding is not due to any widespread preference for this process by those financially responsible for the operation of the railroads; but that the commercial use preceded that of arc welding is due rather, as in the case of automobile lighting, to the fact that these gases were already available, and that the initial development and installation cost necessary for its application was less than that of the electric arc. In view of the widespread movement to replace gas welding with electric welding, it is apparent that the time is rapidly approaching when the relatively small capital outlay will be made to eliminate the high operating expense of the gas welding process.

While it may be true that the actual application of welding does not generally come under the jurisdiction of the electrical men, they have, in the past, done much toward inciting interest, sufficient to result in at least initial purchases of arc welding equipment. As there is yet a great deal of work of this character to be done in the interest of arc welding, your committee feels that the electrical men can do much towards the extension of arc welding by providing themselves with data on the economics of the process, proper equipment, and welding material necessary for the diversified applications of welding, and welding accessories.

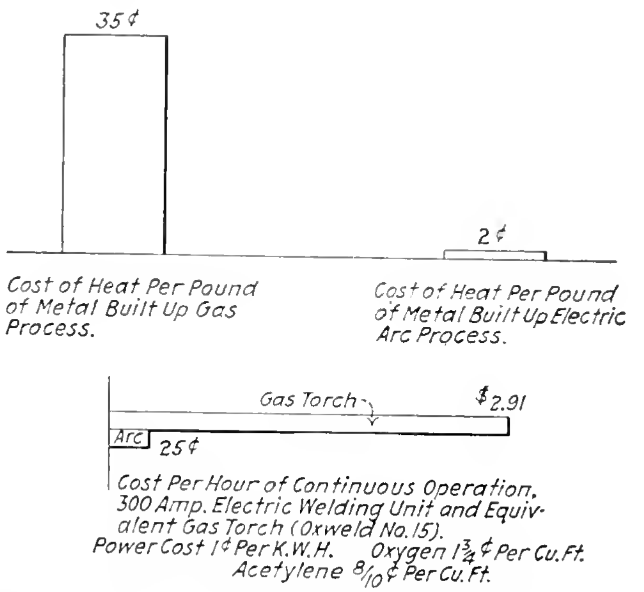


Fig. 3.—Relative Thermal Economies of the Gas Torch and the Electric Arc

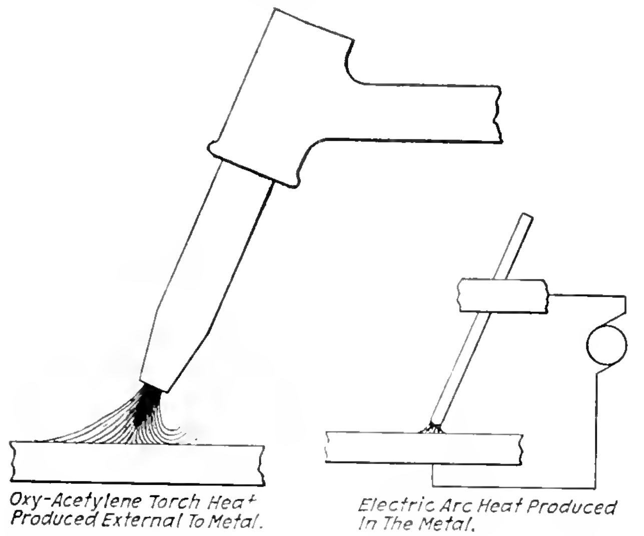


Fig. 2.—Diagram Showing Effectiveness of Heat Produced by Gas Flame and Electric Arc

In this connection, in order to eliminate any hazardous risk, incidental to arc welding, the use of the following safety precautions are recommended:

1. It is very desirable that for use with portable welding generating sets, a combination of a safety switch and receptacle be used. This equipment should be so interlocked that the plug may not be removed without first opening the switch, and may not be inserted unless the switch is open.

It is, of course, desirable, as in the case of all safety switches, that the door be interlocked with the switch handle so that the door may not be opened with the switch closed.

2. Portable cable used between motor and source of power should have an extra conductor inserted for use as a ground wire. For instance, with a three phase motor, a four conductor cable should be used.

The extra conductor should be plainly marked. It is recommended that this conductor be covered with a white braid for marking.

It is further recommended that this cable be covered with a flexible conduit, in which case the flexible conduit may be used to serve as a medium for grounding.

3. Care should be exercised in the grounding of not only the frames of the motor and generator of welding sets, but also the covers and containing cases of switch and control

Size Rod Inches	Power K.W.H.	Arc Current Amp	Cost Per Hour	Cost Per Hour	Tip Size	Oxygen Cu. Ft.	Acetylene Cu. Ft.
1/8	4.5	120	$.045	$.53	6	19.2	23.7
5/32	6.3	140	.065	.80	7	32.0	30.5
3/16	6.7	165	.067	1.16	8	46.0	43.8
3/16	7.9	180	.079	1.51	10	60.0	57.2
1/4	9.6	200	.096	2.21	12	88.0	84.0
1/4	12.50	250	.125	2.91	15	116.0	110.0
1/2	30.0	400	.300				
Electric Power 1¢ Per K.W.H. Oxygen 1¾¢ Per Cu. Ft. Acetylene 8/10¢ Per Cu. Ft.							

Fig. 4.—Comparison of the Cost of Gas Welding With Electric Welding

devices, frames of reactors and all other metal work which might become energized by the failure of insulation on cables, wires, or any part of the equipment.

4. The use of solder to fasten welding cables to ground clamps is not to be recommended. Due to the large currents and to the imperfect connection which is often obtained, resulting in heating of the ground clamp, solder is often partly or totally melted out of the lug. This results, very often, in imperfect operation and finally interrupts the operation entirely. Connection made with some form of clamping connector is more to be desired.

The committee desires to give thanks to Mr. Robert E. Kinkead, welding engineer, for his assistance in preparing the cost data of this report.

Committee: H. R. Pennington, chairman, supervisor of welding and electrical equipment, Chicago, Rock Island & Pacific Railroad; E. Hagensick, electrical engineer, Union Pacific Railroad; E. Lunn, electrical engineer, Pullman Company; E. S. M. Macnab, engineer of electric car lighting, Canadian Pacific Railway; G. T. Goddard, general electrical foreman, Illinois Central Railroad.

Reducing the Smoke Nuisance

Renewed activities by civic authorities and organizations in the campaign to eliminate the smoke nuisance are reported by the United States Department of the Interior following a study of the problem of smoke abatement made by the Bureau of Mines. This campaign was suspended during the world war, when most of the smoke ordinances throughout the country were held in abeyance with the intent of allowing industries to operate unrestrictedly during the time when maximum production was necessary. With the return of normal conditions many cities have shown a determination to take up this matter seriously and work out a solution. Some 50 or 60 cities in the country already have smoke ordinances.

In domestic furnaces, it should be possible to reduce smoke from 50 to 75 percent without spending any money for additional equipment or without change in anything except the methods of handling the fuel. At industrial plants, smoke prevention is merely a matter of management, engineering judgment and designing skill. Any locomotive properly equipped with standardized smoke abatement devices can be made to do its required work without making dense smoke. All metallurgical operations can be conducted smokelessly with powdered coal, coke, fuel oil, or producer gas.

How to Eliminate Smoke

Any operation requiring fuel can be conducted without objectionable smoke, and yet use bituminous coal in some form, states Osborn Monnett, consulting engineer of the Bureau of Mines, who conducted the investigation. If smoke abatement were merely an engineering problem it would present no difficulty. Experience has shown, however, that the problem is not so much an engineering as a psychological one. Until the public is thoroughly roused, demands smoke abatement, and shows continued interest in it, no permanent improvement is possible. Thus the part played by civic organizations and other bodies interested in bettering conditions is of high importance. Smoke abatement is not a matter that can be settled overnight and then left to take care of itself without attention, but is something that must be watched year in and year out if high standards are to be maintained.

The increase of the smoke nuisance in the United States has followed directly the progress of industrial development. When towns were small and a large proportion of the population lived in the country, the smoke nuisance was unknown. As people concentrated in the cities, there followed a tremendous increase in the utilization of power and heat and coal became the only feasible fuel where wood had largely sufficed before.

Soot Deposits Responsible for Nuisance

The deposit of soot on the heating surface of boilers and furnaces causes a serious economic loss by interfering with the efficient transmission of heat from the fire to the boiler or heater. In addition, the smoke that escapes into the atmosphere in smoke-ridden communities causes a considerable per capita loss to citizens through the damage to fabrics and merchandise, and also by the necessary extra cleaning and repairs.

Experiments conducted by the Bureau of Mines at Salt Lake City showed that a tremendous improvement can be made in the smoke performance of domestic furnaces if the firing is done with intelligent care. In the bureau's tests minimum smoke conditions were obtained when various types of boilers and furnaces were fired by what is known as the "coking method," by the "alternate method," and by the ordinary method of firing. One novel idea advanced is the starting of fires from the top, the coal being placed immediately upon the grate with a layer of paper just above the coal and with kindling on top of the paper.

Oil-burning systems offer another method of reducing residence smoke. Most of these systems are automatic.

Prepared fuels offer another possibility for reducing smoke. Of these, coke is probably the most feasible.

High-pressure plants that produce power for miscellaneous manufacturing establishments are the chief sources of industrial smoke. Most of these plants are hand-fired and consist of comparatively small units, approximately 150 horsepower each.

Stoker-fired plants have perhaps been most successful in smoke abatement. The boiler units are generally of large size, are equipped with mechanical stokers, and have been carefully designed by competent engineers. In addition, these plants are under constant supervision by skilled engineers, and firemen are always in attendance.

Cutting Down Locomotive Smoke

Locomotive smoke has seemed most difficult to control, but many cities in the middle west have attempted to solve this problem with more encouraging results than were at first supposed to be possible. In the past ten years standardized equipment has been designed to reduce the discharge of smoke from locomotives. This equipment includes multiple-tip blowers, quick-opening blower valves, and induction tubes in the sides of the firebox to supply the air necessary for complete combustion. Such equipment is simple, is easily added by ordinary boiler makers, and has been discussed in detail in the proceedings of the various railway associations.

Existing Laws Sufficient to Correct Smoke Evil

Success in smoke abatement depends largely on the administration of existing laws. Perhaps the most important consideration is the type of man for administering a smoke ordinance. It seems wise to have an engineer in charge who is familiar with boilers and furnaces and who can understand the engineering problems that will arise when the ordinance is put into effect.

The results of this investigation have been embodied in a report designed to make the various technical problems necessarily associated with the subject of smoke abatement thoroughly intelligible to the non-technical reader. Copies of this report, Technical Paper No. 273, may be obtained from the Department of the Interior, Bureau of Mines, Washington, D. C.

Schiess Machine Works at Düsseldorf, Germany

Building Heavy Boiler Making Tools in Germany*

Heavy Type Punching Machine and Upright Boiler Plate Bending Machine Among Products of Schiess Works

REPRESENTATIVE of the best in German heavy tool building, the machine tool works of Ernst Schiess, known as Ernst Schiess Werkzeugmaschinenfabrik Aktiengesellschaft, is located in Düsseldorf.

The company employs today about 2,000 men, or double the number of pre-war days. There is plenty of work in hand for export, but conditions on the Rhine are now affected by the French occupation of the Ruhr, and the future outlook for these shops, in common with other German industries of like character in the Düsseldorf district, is uncertain. Given a free hand, and there is little doubt that Schiess products would be finding an outlet across seas in as great proportion as before the war.

In the meantime alterations and changes are being carried on in the plant which could not be conducted during a period of large productivity. This will put the works in first-class shape to go ahead whenever the political situation clears up.

The firm produces practically all its own castings, and pieces up to 50 tons are readily cast. The principal tools built in the shops comprise heavy duty lathes, planers, boring, drilling, shaping and slotting machines, tools for boiler making, rolling mills, and for locomotive shops, wagon works and arsenal machinery.

Prior to the war Schiess operated a branch plant at Riga, but this establishment passed out with the war. Just now the noteworthy tools which the Düsseldorf plant is building are a reconstructed heavy duty double bed lathe designed for rapid work on turbine motors, crankshafts, gun and general forgings and marine shafting; a new tire boring mill for railroad trucks and the smaller size locomotive tires; a new profiling tool rest for railroad wheels; a "record" punching machine for curved and rectangular plates; a vertical bending press for use particularly in marine boiler work, and an automatic cutter disk grinding machine.

Machine for Accurate Punching

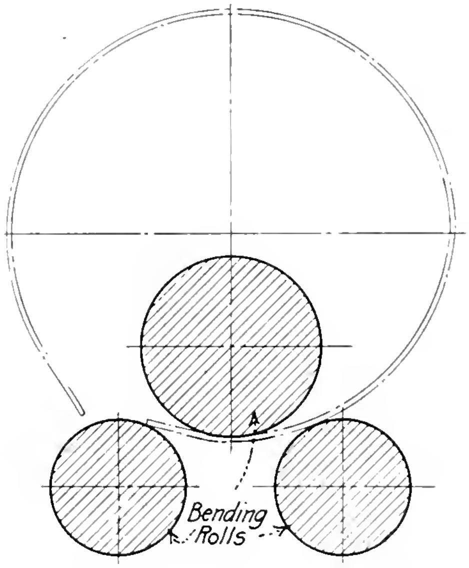
One of the heaviest outputs in numbers during the war, the "record" punching machine, was an important addition to ship construction work and heavy plate work. The Schiess machine will handle curved plates of any form, the machine punching with holes spaced at any regular or irregular pitches, without the necessity of employing formers or other devices. The gap punching and the multiple punching machines have held the field despite many drawbacks, to say nothing of the number of men required to handle them, the former machine largely because of the ability to punch how and where required, and the later machine because suited to deal with rectangular plates with uniform pitch of holes. The Schiess record machine punches throughout the working day 850 holes per hour. The work done is claimed to have accuracy greater than with other types, since in the case of the gap machine much depends not only on the plater, but on the remainder of the gang, whose combined efforts are required to move the plate from mark to mark.

The "record" punching machine comprises the punching machine proper, with operator seat, punches and dies cross traversing over a width of 7 feet 2 inches and the roller

*Abstract of an article "Schiess Machine Tool Works of Düsseldorf" by Captain Godfrey L. Carden, which appeared in *The Iron Age*, April 19, issue.

transporter, in two parts, for feeding the plates longitudinally under the punches. All features of the gun train are in evidence in this design. The roller transporter is actuated by an independent motor, while a second motor actuates the cross traverse of the operator and tools. The operator controls the motor from his seat, which is carried on the cross slide by a simple manipulation of levers similar to those on a Morse telegraph instrument.

The plate can be brought under the punches with the greatest exactitude and rapidity. This is done with celerity. The center finding attachment, which locates the point for



Usual Method of Bending Boiler Shell

punching, consists of two inclined projectors each carrying a small metallic filament lamp. These lights throw a sharply defined and brilliant + on the plate, the intersecting point of which is always exactly under the center of the punch, no matter whether the plates are flat or of varied thickness. This patent center finder is especially valuable when used on dark days or in gloomy shops.

Driving through gearing, an independent motor operates

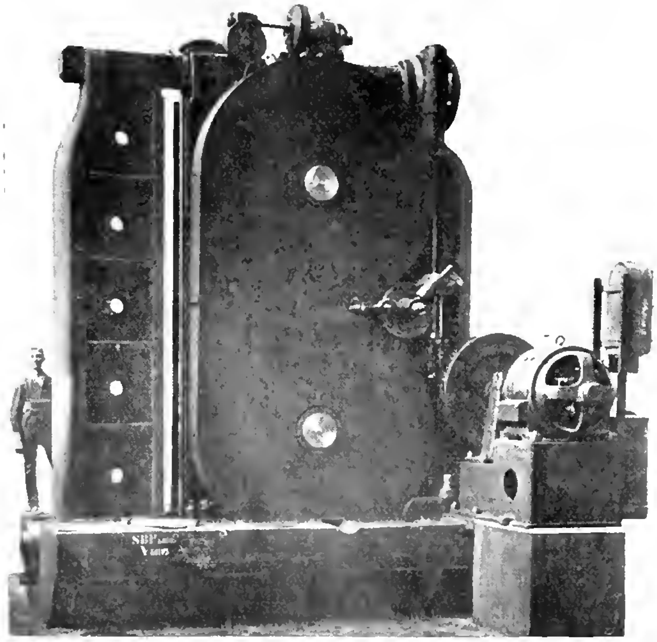
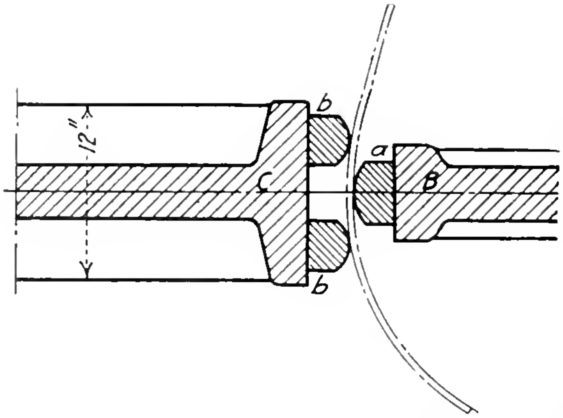


Plate Bending Machine for Boiler Work

Plates are Handled and Supported by Rollers Set Into Floor

the punching mechanism. A claw clutch which disengages after each stroke enables the punch to return automatically to its upper position. The dies are simultaneously lowered so that they are not blunted by the plate traversing over them. Punch and die holders are mounted to the extremity of a U-shaped frame, which is carried in long guides and of sufficient depth to clear the greatest width of plates. Die and die holder are lowered at the completion of each stroke. The punchings or burrs are automatically spilled into a receptacle



Method of Operation of Bending Machine. *C* is Girder Attached to Main Frame, *B*, Stationary Cross Arm, and *b*, *b* Two Cast Steel Tension Members

on the side of the machine. Lubrication of the punches is automatically effected at each stroke.

Upright Boiler Plate Bending Machine

The upright boiler plate bending machine was designed to take care of certain disadvantages in the three-roller plate bending machine. One of these disadvantages consisted in the plate not being bent at all at its ends, due to the center distance of the bottom rolls, as shown in one diagram. Another disadvantage was the difficulty of checking the final shell diameter, as the distortion caused by its overhanging weight, especially with large diameter shells, is considerable. To overcome the latter disadvantage, bending machines with vertically arranged bending rolls were introduced, but this arrangement, it was found, could not compete with the higher efficiency and greater convenience of the boiler plate bending press.

Schiess has brought out a motor-drive press in contradistinction to the hydraulically operated press, which latter for years has been familiar in most shops. The hydraulically operated machines counted as difficulties leakage of pressure at the motor, and the necessity of avoiding temperatures below freezing. The principle of the Schiess machine is seen in a second diagram. The accompanying photographs show front and rear views of the machine. From the diagram and the other illustrations it will be seen that there are a powerful main frame *a* of cast iron, and two tension members *b* of forged steel, which serve to hold in place the strongly constructed stationary cross-beam *B* of cast steel. Reciprocating and arranged between *A* and *B* is the strongly ribbed girder *C*, also made of cast steel.

Vertical Plate Bending Machine

	S. K. P.	1 S. K. P.	2 S. K. P.
Thickness of plates capable of bending	$1\frac{1}{4}$ in.	$1\frac{5}{8}$ in.	2 in.
Maximum width of plates capable of bending	13 ft.	13 ft.	13 ft.
Tensile strength of material which can be negotiated (tons per sq. in.)	29*	29	29
Power required for main motor (hp.)	40 to 45	55 to 60	75 to 80
Speed of main motor	1000 r.p.m.	750 r.p.m.	750 r.p.m.
Power required for motor actuating top tension member (hp.)	4	5	6
Speed of top tension motor	1000 r.p.m.	1000 r.p.m.	1000 r.p.m.
Weight of machine in tons	50	60	68

*Equivalent to 65,000 lb. per sq. in.

Passage of the shell plate through the machine is progressive and automatic. To reduce friction, the plate is carried along on roller bearings arranged on either side at the base of the machine. On its top side the machine carries the motor and gearing actuating the top tension member, which, for the purpose of lifting out the finished plate cylinder, is turned into a vertical position. Details of three sizes of this machine are carried in the table.

Among the advantages of the machine are claimed to be greater number of strokes per minute and therefore greater production, no leaking of pistons or valves, no freezing of hydraulic pipes, and that it is always ready for use whenever required.

Safety Problems of High Pressure Vessels*

Unfired Pressure Vessels Used in the Chemical Industry Offer a Broad Field for Development

By Samuel S. Caskey†

THE subject, high pressure vessels, as understood in this discussion, deals with those vessels employed in chemical and similar processes other than steam vessels, such as boilers, steam accumulators, digesters, air pressure tanks, hydraulic apparatus, etc., for which laws have already been laid down and formulæ for designing have already been authorized and compiled by many states; the American Society of Mechanical Engineers and other engineering societies. They are variously called in the trades, autoclaves, converters, reactionary kettles, thionators, chloronators, carbonization kettles, dissolving kettles, fusion kettles, jacketed nitrators, sulphurating kettles, etc. The typical vessel I have selected is the autoclave, or closed, high pressure, high temperature, agitation vessel, carrying pressures from 60 to 1,500 pounds and temperatures from 212 degrees to 600 degrees F.

Eight or ten years ago most of the designs followed England and Germany, but since then they have been redesigned and built more according to American ideas. In the same time there have been built in this country about 200 different types, of which I have designed 70 or more types for the company with which I am associated. In fact during that time the advance in high pressures and high temperatures has been very marked, and it is hard to tell how rapid the demands on our ability to design and our knowledge of materials will be.

Higher Pressures Used

We are at present reaching pressures double this and temperatures approaching the critical temperature. The distinguishing feature of all these vessels is the combination of such advanced pressures and temperatures which set up complicated and terrific strains and I wish to tell you some of the troubles we have had in our experience in designing for efficiency and safety. You will appreciate these troubles when you learn some of the requirements of the processes that have to be considered.

The higher pressure vessels are nearly all closed fusion reactionary vessels and seldom have there been two of the same design, some detail always varying for a special reason. Heating and cooling in these vessels is nearly always very rapid to save time in the process yet some of the processes last three to four days. One instance of terrific grief to any kind of vessel is the case we have of a reaction kettle in which at a critical point in the process and when the materials are at red heat, water is introduced to produce pressure within the vessel for decanting a very quick setting material. Imagine the expansion and contraction strains under this treatment; the control depends entirely on the operators watching the steam gage. In many cases the reactions get beyond control and safety valves must be relied on. In other cases it is hard to get the proper heat arrangements so that there may be uniformity of heating.

Some vessels requiring low temperatures may be heated by steam jacketing. High temperature vessels must be heated by oil jacketing and vessels requiring still higher temperature may be fired directly with gas or oil, and we have still other types that must be heated to the critical pressure and critical temperature, which means that this combination of pressure and temperature is the point at which water and steam have the same properties, that is, the same weight per cubic foot and the same heat content. Another way of putting it, is, we have come to the end of our steam tables as they are used today and modern authorities differ as to their exact value. You will see that we have already arrived at a mechanical and manufacturing stage which had its inception over fifty years ago and had to do with the realm of thermodynamics. In fact we are beginning to work with a condition that is very unstable and beyond which little or nothing positive is known as yet.

At this writing we have news from England of a steam

*From a paper read at the annual meeting of the National Safety Council, Buffalo, N. Y., October 3.

†Engineering department, E. I. Du Pont de Nemours & Company, Wilmington, Del.

plant using 3,200 pounds pressure and 706 degrees F. temperature.

Problems Met in Construction

Our first task and first considerations were metallurgical, that is, whether the vessels should be made of cast iron, steel, or welded steel, and what quality of welding should be used.

Most European designers carried extreme fiber strains which were too high for this class of manufacture, because there is a safety factor for expansion and contraction required beyond anything allowed in the past. Seldom, if ever, do we allow strains greater than 6,000 pounds in cast steel, 1,500 to 2,000 pounds in cast iron. Autogenously welded vessels are permitted to carry 8,000 pounds extreme fiber strain, but electric or acetylene work should not be used except for very moderate pressure in welding pressure-vessels because of the human element entering into the welding operation, and the greater susceptibility to corrosion of the weld.

Our second problem was to design a vessel of such shape as could economically handle the quantity of material which was to be worked and of such shape that the greatest strength and adaptability would aid in the fabrication of the vessel.

In all of these different types and combinations of temperatures and pressures, we have had the difficulty of supplying proper safety valves or relief mechanisms.

We have already designed two types of safety valves, neither of which has been entirely successful and it is our problem to go further with this item.

Details of Vessel

The general outline of the vessel in mind is a flanged cylinder with a spherical bottom, closed with a lid also spherical and flanged, with the drive mechanism, manholes, thermometer wells, sampling entrances that are to be accommodated and superimposed. The most difficult problem is that of making the joint between the lid and body. The material of the joints must first withstand the chemical action of the charge. It must also be tough enough to resist the pressure on the joint. The ordinary fabric and composition materials fail very often and quite often we must introduce grooves and metallic gaskets, but we are not yet able to consider this matter solved.

The fact that all drives, manholes, thermometer wells and sampling entrances must be accommodated on the lid and all joints packed makes the problem one of machine design.

Another trouble, subject for consideration, is the agitator which at present has no system of design whatever. The energy consumed by a badly designed agitator is very great, and I might say the efficiency and the yield of any process of necessity depend on whether an agitator does the proper work or not.

Design of Bolts for Pressure Vessels

Our experience has taught us that in designing bolts for the head, care should be taken not to have these bolts too powerful, for the reason that in erecting the autoclave they might be pulled so tight as to strain the flanges and thereby make the joints conical. Once this happens, it is almost impossible to recover tightness.

We have learned also that when open slot holes are used in the upper flange of the vessel, they positively must be round and not square at the bottom of the slot, because in casting, shrinkage strains develop at sharp corners, and in bolting, they will gradually fatigue under repeated tightening of the bolts and rupture. In casting a vessel, it is necessary to cast it with the flange up so that the bottom will be of clean material without blow-holes, sand-holes or cold shots, therefore, such material should be run as a header to the flange metal to make a homogeneous and perfect flange. This same applies to the lid. We have been compelled to give up casting vessels of so-called semi-steel, except in very small dimensions, for it is impossible in a large casting to keep the steel from segregating at the bottom while cooling in the mold. It invariably results in a distinct line of separation between the cast iron and the steel, and particularly in direct firing, will result in the expansion and contraction taking place in this particular line and nearly always breaking away causing damage and danger.

Frequent Inspections Made

Considering the increased requirements over usual custom and, after a discussion with all those concerned, we ordered to be followed out a definite plan of periodic inspection and report to detect weakness and forestall accident. Following out these orders, an inspector versed in this work and with proper mechanical education, was appointed to make the first inspection. For his aid, I prepared two questionnaires, one for data to be collected, and one on which to report inspection facts. All vessels were fitted with thermo-couples and potentiometers for observation and control during operations. Test data of manufacturer was stamped when possible and posters of the last inspection were attached to create confidence and establish morale. We have followed, and are still following up these inspections.

INSPECTION OF PRESSURE VESSELS DESIGN DATA

Diameter and length (inside)	3 feet 0 inches, 5 feet 9¾ inches.
Capacity in gallons	325
Material and thickness of shell	Cast steel 2¼ inches thick.
Type and efficiency of long. seam	None.
Size and spacing of rivet holes	No rivets.
Size and pitch of rivet holes	No rivets
Type and efficiency of cir. seam	None.
Shape and thickness of cover	Convex.
Kind of material in cover	Cast steel.
Shape and thickness of bottom	Convex.
Kind of material in bottom	Cast steel.
Number and dia. of bolts	20 3-inch diameter.
Calculated bursting pressure	4,800 pounds.
Test pressure	900 pounds.
Working pressure	600 pounds.
Stress in shell	7,200 test pressure; 4,800 working pressure.
Stress in cover	7,200 test pressure; 4,800 working pressure.
Stress in bottom	7,200 test pressure; 4,800 working pressure.
Stress in bolts, middle	15,500 test pressure; 10,200 working pressure.
Stress in bolts, main	15,000 test pressure; 10,000 working pressure.
Kind of gaskets	
Source of heat	Gas fired.
Extreme temperature	240 degrees C.

DETAILS OF PRESSURE TEST

Hydrostatic test applied	900 pounds.
Test temperature	120 degrees to 125 degrees C.
Duration of hydrostatic test	1 hour.
Description of leaks	None.
Pressure ordinarily used	600 pounds.
Maximum working temperature	240 degrees C.
Size and type of safety valve	Lonergan-found loaded to 750 pounds.
Number of safety valves	One.
Location of safety valves	On discharge line outside of bldg.
Safety valves loaded to	750 pounds.
Type, dia. and thickness of safety disc	Tagger's tin $2\frac{3}{16}$-inch dia.—.012-inch thick, found broken.
Number of safety discs	One.
Location of safety discs	Between vessel and safety valve.
Fracturing pressure of safety discs	750 pounds.
Date new safety disc was inserted	July 10, 1923—Tagger's tin .010 thick, $2\frac{3}{16}$-inch. dia.
Condition of bolts and studs	Good.
External condition of shell	Good as far as can he seen.
Internal condition of shell	Not examined.

Up to the present time, a total of 60 pieces of apparatus has been inspected and tested. In most cases, leaks were discovered at gaskets and fittings. Wherever it was possible to stop these leaks by the tightening of bolts or making slight adjustments, this was done. Where we found it impossible to overcome them, however, except by inserting new gaskets or making repairs, a record has been made on our inspection data sheets.

In general, vacuum apparatus shows more pronounced leaks than pressure vessels. This is to be expected, since leaks of this nature are not self-evident, but are only found by test.

The Determination of Chimney Sizes—II*

Charts and Examples Showing a Logical Method of Designing Stacks and Checking Performance

By Alfred Cotton†

FIG. 10 shows that at 0.5 of maximum capacity the draft loss due to acceleration of gases is 0.09 of that at maximum capacity, or, say 0.10 for use in this approximate way. Fig. 1 shows that the available draft at 0.5 of maximum capacity is 0.91 of the static draft. Therefore the draft required at the chimney base divided by 0.9, for this approximate work, and added to the draft loss due to acceleration of gases gives the required static draft. The necessary height of chimney can then be directly read from Fig. 2 or Fig. 3 after making due allowance for temperature drop with the aid of Fig. 5.

The accuracy of the results depends only upon that of the constants. For all ordinary cases only a few of the charts are used, and it is an exceedingly simple matter to solve any problem.

A central power station is to have groups of four 1,400 horsepower boilers to each chimney. The boilers are to be 14 tubes high and are to carry peak loads of 300 percent of rating when the exit gases will be at 640 degrees. Forged-draft stokers are to burn bituminous coal of known analysis with 50 percent of excess air.

An approximate idea of the chimney is first arrived at. The total horsepower to be handled is 16,800, for which a diameter of 16 feet is read from Fig. 17.

The draft required at the base of the chimney is found to be 1.55 inches made up of 1.3 inches draft loss through boiler (from Fig. 12), 0.15 inch draft loss through the flues, and 0.1 inch vacuum over the fire. Dividing this by 0.9 gives 1.72 inches as equivalent static draft, to which is added an assumed 0.1 inch for acceleration of gases, making a total static draft of 1.82 inches. Assuming a mean temperature of chimney gases of 550 degrees, a height of 270 feet is found from Fig. 2.

The combustion data for the coal are worked out and the total weight of gases per pound of combustible found. Using the predicted boiler and furnace efficiency, the weight of combustible per hour is found and then the weight of gases per hour. Tabulation of data is then commenced as in Table 2, using a number of diameters above and below

*Continued from page 289 of the October issue. From a paper presented at the spring meeting, Montreal, Canada, of the American Society of Mechanical Engineers, Abridged.

†Chief of research department, Heine Boiler Company, mem. A. S. M. E.

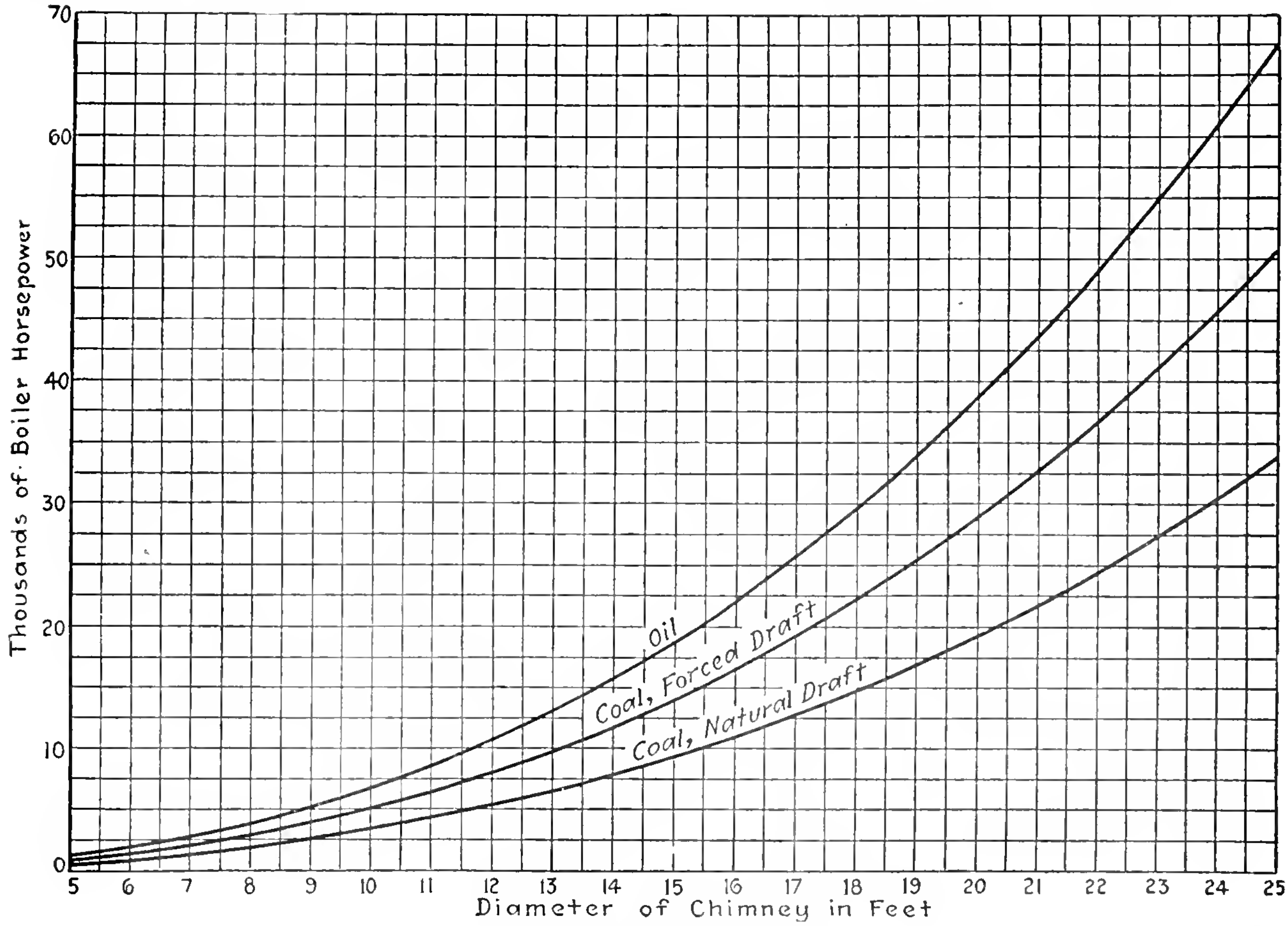


Fig. 17.—Working Capacity of Chimneys from 5 to 25 Feet in Diameter, Based on Boiler Horsepower with Atmosphere at 60 Degrees F. at Sea Level

(Maximum capacity = 95 percent of maximum capacity with mean temperature of gases at 900 degrees F. Working capacity = 30 percent of maximum capacity [or 28.5 percent of maximum capacity at 600 degrees F.]. Weight of gases = 90 pounds per hour for natural draft, 60 pounds per hour for forced draft, and 45 pounds per hour for oil.)

the first approximation. The first approximation of heights appropriate to the listed diameters is given in column 7 and is made on the assumed mean temperature and gas acceleration loss. A close determination is now made of mean temperature in accordance with each combination of approximate height and diameter and of the actual loss due to acceleration of gases. This leads to a new series of heights as entered in column 15. A curve of heights as in column 15 is now drawn against the diameters of column 1 as the full line of Fig. 18 and simplifies the final choice. Such a curve shows the practical limits at each end of the series very decidedly.

It was pointed out by Deinlein that of a series of possible chimneys, the one whose product of diameter by height was the smallest would be the least expensive. These products are entered in column 19 of Table 2 and their curve drawn in Fig. 18 as the broken line. The lowest point in this curve occurs at 14 feet 6 inches diameter where the height is 289 feet. The author is indebted to Mr. George H. Gibson, Mem. A.S.M.E., for this information.

A problem frequently met with is that of modernizing and increasing the steaming capacity of a plant while using the existing chimney.

A curve of exit gas temperatures is first drawn and then a curve of the corresponding mean temperatures of the chimney gases as in Fig. 19. These are used to determine the characteristics of the chimney as in Fig. 20; and as this is based on weight of gases, it must be related to Fig. 19, which necessitates a curve of gas weight per horsepower depending on the curve of efficiency. The draft loss through the boilers is determined and plotted. The areas and arrangement of flues are carefully examined because desirable reduction of their draft loss can usually be made by redesigning them. The predicted flue draft loss added to the boiler draft loss and to the vacuum necessary over the fire, will enable the

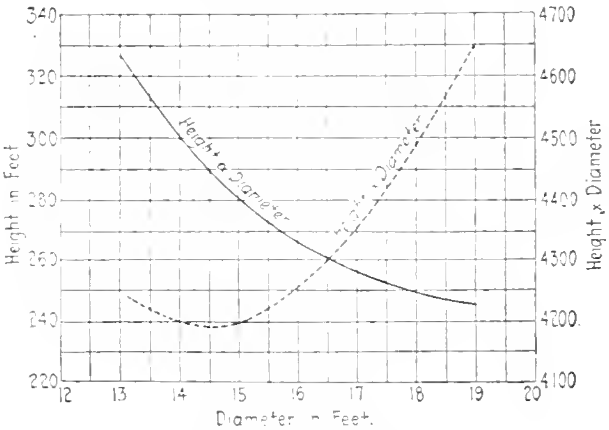


Fig. 18.—Chimney Study Giving a Series of Combinations of Height and Diameter

curve of draft required at base of chimney to be drawn as in Fig. 19. With the mean temperature of chimney gases, the static draft for different loadings is read from Fig. 2 and plotted.

The fraction of static draft for different fractions of maximum capacity is found from Fig. 1, and the equivalent draft for each percentage of boiler rating noted. The loss due to acceleration of gases is then found and deducted therefrom, leaving the available draft at the base of the stack at each percentage of rating at which the boilers might be worked. Curves are then drawn of these available drafts as in Fig. 20. The draft required at different ratings is read from Fig. 19 and enables the broken-line curve of maximum chimney load at different boiler-rating loads to be drawn in Fig. 20.

The actual boiler horsepower which the chimney will carry

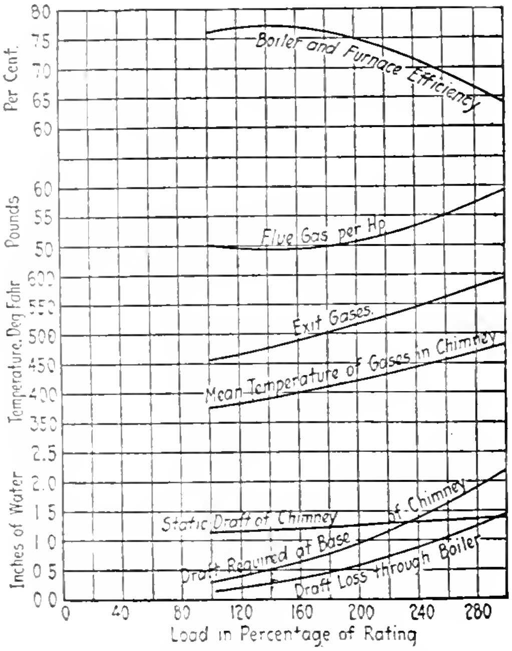


Fig. 19.—Chimney Study; Performance Data of an Existing Chimney

at different boiler ratings is obtained by dividing the total gas weights of Fig. 20 by the gas weight per horsepower of the curve of Fig. 19. To show this more clearly, the curve of Fig. 21 may be drawn. This curve emphasizes how the chimney capacity is governed by the draft loss of the boilers and flues. If the flues were enlarged, the chimney capacity would be greatly increased. This curve also shows that the capacity of the chimney is increased enormously if the boilers are run at low ratings owing to the much lower draft loss at low loads.

The requirements may be met by reducing the excess air, by improved methods of firing, by installing induced draft, or by adding more boilers and running at lower boiler ratings. The first and last methods increase boiler efficiency and save coal, while the second method increases the coal consumption by running at higher boiler ratings where the efficiency is lower.

Other examples are given in the complete paper which show that the system is as well adapted for finding approximate but reliable chimney sizes as it is for making more accurate studies of chimney characteristics for large and important plants such as the one immediately preceding.

Discussion

THE discussion was opened by the reading of a communication from Julian C. Smallwood[1] in which he pointed out that the author's method was an elaborate structure based on two slender supports, namely, Menzin's coefficient for frictional resistance in chimneys, and the author's estimate of mean temperatures of chimney gases.

Menzin had assumed the hydraulic equation for friction to hold, although there was no experimental proof that for such large gas flows as those in present-day chimneys that it did hold; and had selected the coefficient 0.008 as a compromise between 0.012, from the crude experiments of Gale, and 0.006, from the limited data of Peclét, both obtained prior to 1890 and therefore scarcely up to date.

The author's calculations for chimney height were based on mean stack temperatures instead of temperatures at the base

[1] Assoc. Prof. Mech. Eng., Johns Hopkins Univ., Baltimore, Md., Mem. A.S.M.E.

of the stack, which was a correct procedure. Curves were presented in the paper to show the relation between mean temperature of stack gases and temperature at base. These curves were based on experiments made at the Massachusetts Institute of Technology and still more recent ones at Johns Hopkins University. Professor Smallwood could not speak for the former, but having himself conducted the latter experiments, he wished to emphasize the fact that the temperature gradients obtained had been influenced not only by air infiltration through idle boilers but by leakage at the

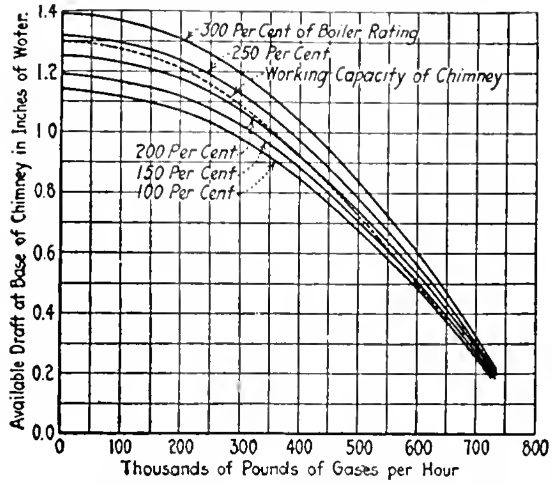


Fig. 20.—Chimney Study; Working Load of an Existing Chimney at Different Boiler Ratings

joining of the breeching and the chimney. This possibly accounted for the rapid temperature drop of the gases upon leaving the breeching, as shown by Figs. 2, 3, and 4. As had been pointed out in the report of the Johns Hopkins tests, it was absolutely essential for correct chimney design that the mean stack-gas temperature be calculated with some degree of precision, and that loading of the chimney by cold air be prevented. If the author had given the Johns Hopkins tests much weight, his results would possibly be more applicable to chimneys leaking air at the base than to the tightly sealed chimneys of modern large power plants.

Professor Smallwood questioned the author's statement that the maximum capacity of a chimney was independent of its height. This might be true if the stack gases would only remain at a constant temperature; as a matter of fact they inevitably decreased, radiation alone being sufficient to account for this phenomenon. The higher the chimney, the lower became the temperature of the issuing gases. As the temperature fell, the density of the gases increased, and the increment of draft due to each increment of height became less and less. On the other hand, the frictional resistance per increment of height remained constant, and in consequence there was a limit beyond which the increased frictional resistance was greater than the increased draft, resulting in a lessening of available draft at the base, as well as in capacity.

Despite the preceding criticisms, Professor Smallwood considered that the author had made a real contribution toward the solution of the problem of chimney proportioning and that his method of arriving at definite results was by far the best yet presented. It was of the highest importance, however, that additional experimental data be obtained, and power-plant superintendents should cooperate in experimenting on large chimneys to determine friction losses, the factors with which they vary, and the laws relating them; determining the exact relation between temperature of gases and height of chimney; and investigating the influence of air infiltration, down drafts, stratification, eddy currents, etc. Until this was done, chimney design must remain much where it was.

T. A. Marsh[2] wrote that chimneys were not power generators and were not subject to classification on a horsepower basis. They fulfilled the same function as fans and should be rated by the same units of measurement, namely, gas volumes and pressures.

The large problem was one of judgment as to what variables to use. Such items as the flue-gas temperature as affected by operating conditions, friction losses as affected by fouling of boiler passes, quality of coal and provision for worst coal as affecting the weight of air, were all subject to considerable variation, and judgment based on ample experience was required to select the proper values. There was also the question of the probable operating conditions that might exist five or ten years hence in the plant in reference to plant development and growth, as well as that of the capital investment for plant expansion.

E. L. Hopping,[3] who opened the oral discussion, said that some years ago he had occasion to design the stacks for a modern plant, and found that the various formulas available for that purpose gave stack diameters ranging from 8 to 12 feet for a given case. The old stack formulas, which were based on hand firing, would not apply to the great variety of conditions obtaining in stoker firing, and in this respect he felt that the author had presented something definite that could be depended upon.

Great care had to be exercised in making assumptions regarding gas conditions—whether they would be uniform throughout the stack or whether considerable excess air would filter in at some intermediate point. Further, radiation losses would be greater in steel stacks than in those built of brick unless the former were lined from bottom to top.

N. E. Funk[4] said that while two of the fundamental quantities used in the author's method were assumptions based on scanty experimental data, he nevertheless believed that it would be found to yield more accurate results than anything

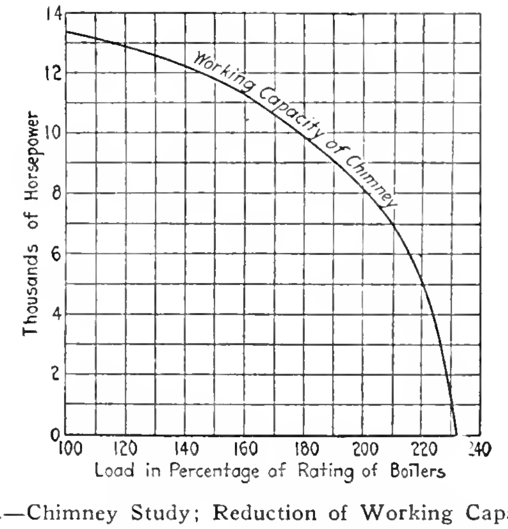


Fig. 21.—Chimney Study; Reduction of Working Capacity of an Existing Chimney at Increased Boiler Ratings

else published on the subject. The formula for friction might be open to question as the friction varied with the condition of the surface, and the surfaces differed widely as regarded roughness. The velocity to be used in such calculations was that at the sides of the stack where the friction occurred, and not the average velocity of flow through the stack cross-section, which was higher.

A. G. Christie[5] confirmed what Mr. Hopping had said in

[2] Ch. Engr., Green Engrg. Co., E. Chicago, Ind. Mem. A.S.M.E.
[3] Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. A.S.M.E.
[4] Operating Engr., Philadelphia Elec. Co., Philadelphia, Pa. Mem. A.S.M.E.

regard to the diversity of results obtained from various stack formulas. The previous summer, in connection with the design of chimneys for the pulverized-fuel-burning station being constructed in St. Louis, he had had some of his assistants gather a large amount of performance data from chimneys in modern plants in order to determine whether an empirical formula might be derived that would be suitable for the work in hand, and it had been found that practically every chimney considered had been designed, with certain modifications, according to Kent's original formula.

Professor Christie agreed with Mr. Funk that surface friction was involved as well as fluid friction. In the work which Professor Smallwood had conducted at Johns Hopkins, thermocouples having been found untrustworthy, a large resistance thermometer had been built to measure the average temperature across the chimney. This fitted the inside of the stack nicely and could be lowered from top to bottom. For a long time no explanation had offered itself as to the very great temperature drop that took place between the outlet of the boiler and the top of the stack; but at last it was found that the breeching had been cemented into the stack cold, and that heating had dished it inward from the chimney, leaving large openings through which cold air entered. Consequently the published results of the Johns Hopkins experiments would have to be used with a considerable measure of caution as they did not represent good chimney conditions.

While there were many variables involved in chimney design, Professor Christie concluded, all but a few were unimportant and could be neglected. Certain definite items such as velocity, mean temperature difference, and friction loss could be determined, and then three or four of the important variables might be selected and some real experimental data obtained on them which would make it possible to design a chimney with a reasonable degree of accuracy.

F. F. Uehling[6] said that air infiltration between the boiler and stack, though not given much thought, was a serious matter. In the majority of the plants which he had had occasion to examine in this regard he had found that the CO_2 percentage at the base of the stack ranged from 3 to 5 percent. When the gases left the boiler the percentage was from 10 to 12, which meant a tremendous infiltration of air, in fact, so much so that the stack was burdened with 100 percent more gas than it should carry away.

Others who briefly commented on the paper were Max Toltz,[7] who welcomed the new method as one that would make it possible to design stacks rapidly and with accuracy; and W. B. Frost, who believed that the new types of airtight flues would do away with much of the uncertainties in design caused by air infiltration

[5] Prof. Mech. Eng., Johns Hopkins University, Baltimore, Md. Mem. A.S.M.E.
[6] Pres. and Combustion Engr., Uehling Instrument Co., Paterson, N. J. Mem. A.S.M.E.
[7] Mech. Engr., Toltz, King & Day, Inc., St. Paul, Minn. Past Vice Pres., A.S.M.E.

In his closure, the author said that he believed that Professor Smallwood had overlooked one or two points set forth in the paper. It was obvious that the maximum capacity being independent of the height was based upon having the same conditions in all cases, including the mean temperature of the gases. If comparison was being made of two actual or proposed chimneys of different heights, the appropriate mean temperatures would be found as directed, so that this point was fully taken care of in the paper.

Leakage of air at breechings did not impair the method presented in the paper because the designer must naturally base his calculations on the weight of gases going up the chimney.

No one deplored more than the author the lack of information on chimney performance, or would more heartily welcome exhaustive research. However, Professor Smallwood would see on further consideration, that the method was not based on the slender support of the meager information now available but simply utilized what knowledge was so far available. As shown in the paper, further research would enable more accurate results to be attained by the use of the method. But to impugn the method because of lack of authoritative data was like suggesting that we discontinue the use of the micrometer until we have decided whether the inch or the meter is the better unit with which to graduate it so that it will be accurate.

In preparing the curves for finding mean temperature, the curve of temperature drop No. 1 in the Appendix was given the greatest weight since it was the only one in which the weight of gases was even approximately known. As the weight of gases in the Johns Hopkins tests was not given, no considerable use could be made of them except in a very general way.

Mr. Marsh had drawn attention to the variables to which consideration must be given, and these should always be borne in mind in determining chimney sizes. The various allowances which experience suggested were easily taken care of in using the proposed method.

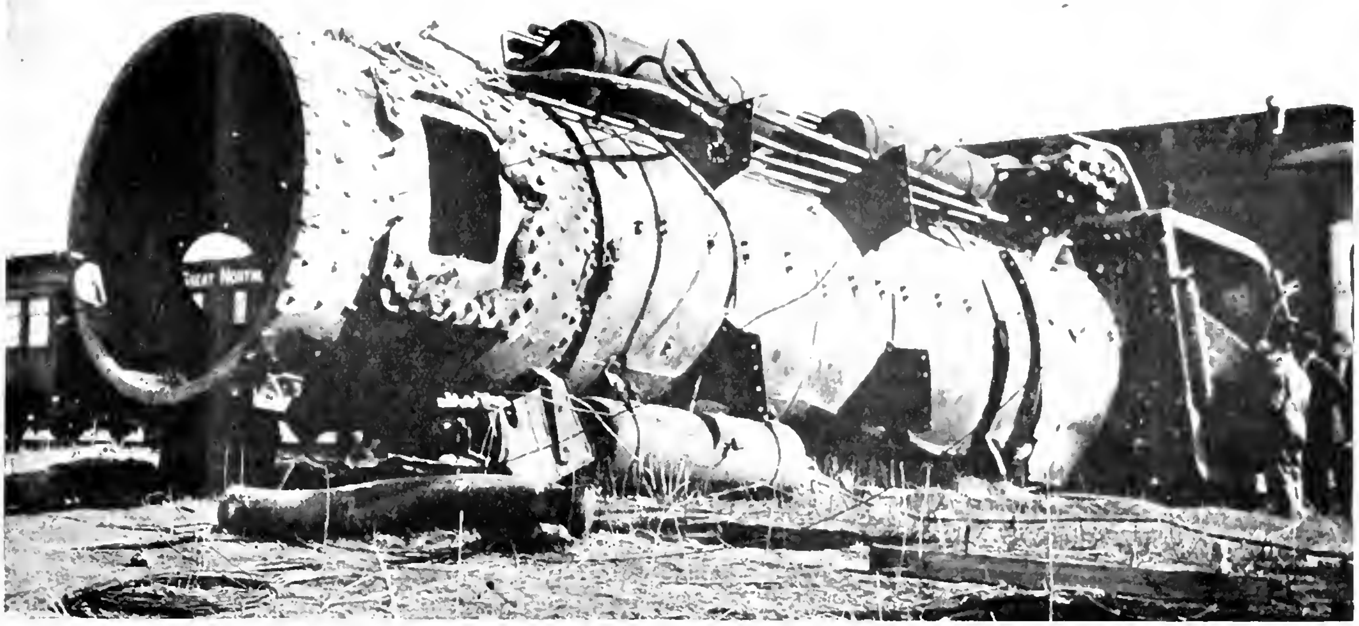
Mr. Hopping had well emphasized the chaotic state of the art. If reliable results were desired, it was imperative that gas weights be used rather than boiler horsepower. When this was done, no trouble was experienced such as that caused by the different proportions of excess air in hand firing and modern machine firing.

In reply to Mr. Funk, the lack of experimental data affected the accuracy obtained by the use of any method of chimney computation, but in no way detracted from the value of the method itself. So far, friction had been based on volume passing and consequently on average velocity, and that really seemed to be the most convenient way, as it included both surface and fluid friction.

Replying to Professor Christie, the author said that further chimney experiments should include gas analyses at different

TABLE II CHIMNEY STUDY

(1) Diameter in feet	(2) Maximum capacity as ? in Fig. 7.	(3) Working capacity = fraction of maximum capacity	(4) Draft required, fraction of static draft	(5) Draft required, 1.55 in. ÷ col. (4)	(6) Static draft required = col. (5) + 0.1 for gas acceleration	(7) Height with mean temperature at 550 deg. Fahr.	(8) Factor for mean temperature	(9) Mean temperature difference	(10) Mean temperature of chimney gases	(11) Draft loss by gas acceleration at maximum capacity	(12) Fraction of gas acceleration at working capacity	(13) Gas acceleration at working capacity	(14) Total static draft required	(15) Height required at mean temperatures of col. (10)	(16) Factor for mean temperature	(17) Mean temperature difference	(18) Mean temperature of chimney gases	(19) Product of height by diameter
13	2,000,000	0.429	0.815	1.902	2.002	297	0.795	461	521	1.30	0.183	0.238	2.140	327	0.792	459	519	4251
14	2,380,000	0.360	0.870	1.782	1.882	280	0.805	467	527	1.40	0.130	0.182	1.964	300	0.803	466	526	4200
15	2,820,000	0.304	0.908	1.707	1.807	268	0.815	473	533	1.51	0.092	0.139	1.846	280	0.814	472	532	4200
16	3,320,000	0.258	0.932	1.663	1.763	261	0.824	478	538	1.62	0.066	0.107	1.770	266	0.824	478	538	4256
17	3,860,000	0.222	0.950	1.632	1.732	257	0.833	483	543	1.73	0.049	0.085	1.717	256	0.833	483	543	4352
18	4,450,000	0.193	0.962	1.611	1.711	253	0.841	488	548	1.84	0.037	0.068	1.679	249	0.842	488	548	4482
19	5,090,000	0.169	0.971	1.596	1.696	251	0.849	492	552	1.95	0.028	0.055	1.651	245	0.850	493	553	4655



General View of Great Northern Locomotive No. 320 after Wreck

Fatal Boiler Explosion Caused by Low Water

Overheated Crown Sheet Failure on Great Northern Locomotive Causes Loss of Three Lives

On another page of this issue appears a first-hand account of a Great Northern locomotive disaster that occurred April 16 near Minot, North Dakota. The suggestion was made by the writer of this communication that a detailed report of this explosion would be of special interest to many of our readers who are familiar with the circumstances connected with the disaster. For this purpose, A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, has supplied the details of his official investigation and report which are published below.

On April 16, 1923, at 4:20 p. m., the Great Northern locomotive 3201 left Minot Yard, N. D., in charge of engineer C. C. Bonnewell and fireman Fred Remus, en route to Williston, N. D. The train proceeded to Des Lacs, N. D., approximately 14 miles, where a stop was made for water, then proceeded to a point about 1½ miles east of Roach station, approximately 27 miles west of Minot, operating on a grade varying from 0.6 of 1 percent to 0.72 of 1 percent, when the boiler exploded causing the death of brakeman Thorsdahl and the fatal injuries of engineer Bonnewell and fireman Remus, who were riding in the cab of the locomotive at the time of the accident.

This was a large Mikado type locomotive constructed by the American Locomotive Company in March, 1919. The force of the explosion tore the boiler from the frame and running gear, hurling it forward for a distance of approximately 190 feet, where it first struck ground on the back head of the boiler, making a dent in the earth about three feet deep, then rebounding approximately 70 feet, striking the ground with the front end, rebounding the second time approximately 60 feet, striking on the right top side of the knuckle of the back head, finally coming to rest on the right side of boiler at a point 330 feet from the point of explosion. The running gear was not derailed.

Engineer Bonnewell's body was found directly opposite the point of explosion on the right side of the track against a telegraph pole, approximately 30 feet from tracks. Brakeman Thorsdahl's body was found on the right side of the track, near the right-of-way fence, about 30 feet back from the point of the accident. His left arm was torn off and found near the right-of-way fence about 75 feet ahead of the point of accident. Fireman Remus' body was found about 50 feet back from the point of the accident on the left side of the track, near the cab of the locomotive.

Construction of Firebox

The boiler was of the extended wagon top type, with a radial stayed firebox and combustion chamber. The com-

heights, so that the draft loss and temperature drop within the chimney could be more definitely related to gas weight than can be done at present.

The author agreed with Mr. Uehling as to CO_2 readings and excess air, and could confirm his experience as to serious air leakage losses in very many plants. The use of CO_2 recorders should be increasingly encouraged; and in many cases, a CO_2 recorder connected to the chimney would be very valuable.

It was very interesting that Mr. Toltz had used the method in comparison with others. The advisability of having a simple method could not be gainsaid, and simplicity was an outstanding feature of the system.

Replying to Mr. Frost, the author said that he had found many overloaded chimneys that were not overloaded with useful work but with unnecessary air. Unless flues were air-tight, the chimney would be unnecessarily overloaded.

Chimneys should in general be designed on a basis of gas weight. The curves based on boiler horsepower were only intended for approximate or preliminary work.

bustion chamber door, side and crown sheets were constructed of steel plate 7/16 inch in thickness. The flue sheet and inside throat sheet were 9/16 inch in thickness. The crown and side sheets were of one-piece construction. The seams in the door hole as well as the seam between the crown sheet of the combustion chamber and firebox proper were autogenously welded, while all the other seams were riveted.

The crown sheet including the combustion chamber was supported by 20 longitudinal and 31 transverse rows of radial stays $1\frac{1}{8}$ inches at the crown and roof sheet ends with body reduced to 15/16 inch, spaced $3\frac{7}{8}$ inches by 4 inches. The first six longitudinal rows of stays on each side of the center extending from the sixth transverse row to the door sheet had button heads. All other stays had hammered heads. The first four transverse rows were flexible type stays. Other staybolts were spaced $3\frac{7}{8}$ inches by 4 inches and were $\frac{7}{8}$ inches in diameter.

The locomotive was equipped with a Schmidt type superheater, having 45 units. The firebox was equipped with four 3-inch arch tubes, carrying a brick arch. The firebox was not equipped with fusible plug or low water alarm.

Examination of Firebox

Investigation disclosed that this explosion was due to the firebox crownsheet having become overheated, due to low water.

The crownsheet of the firebox was overheated from the flue sheet to the door sheet and from the tenth longitudinal row of stays on each side of the center at the flue sheet to the sixth longitudinal row on each side of the center at the door sheet. This made the overheated area approximately 127 inches in length, 75 inches wide at the flue sheet and 48 inches wide at the door sheet. The overheated area showed a distinct blue color, the line of demarcation being well defined and showed water to have been approximately 7 inches below the highest point of the crown sheet.

Failure of Firebox

The initial failure apparently took place in the area between the sixth and ninth transverse rows from the flue sheet near the center of sheet, the crown sheet pocketing down at this point, pulling over button heads of stays and enlarging holes to a maximum of approximately $1\frac{7}{8}$ inches and sweeping toward the back end of the firebox until the eighteenth transverse row of stays was reached, where the initial rupture occurred. This rupture follows a straight line transversely through 29 holes in the crown and right side sheet, continuing down to the mudring. The top of the flue sheet ruptured through the line of the upper row of small flues from the left side to the right top corner of the flue sheet in the combustion chamber and continuing downward close to the edge of the flue sheet flange. It then followed the line of the inside throat sheet flange until the mudring was reached, where 18 rivets were sheared and sheet torn free at this point. The top part of the flue sheet straightened out and still adhered to the crown sheet. About two-thirds of the crown sheet was blown down and pulled a portion of the flue sheet, combustion chamber and right side sheet with it and partially folded back against the left side sheet, leaving the left side sheet intact. These sheets pulled away from 333 staybolts and 406 crown stays, making a total of 739 stays, from which the sheets pulled away. The flue sheet pulled from the top row of small flues, 16 in number, and two superheater tubes.

The autogenously welded seam in crown sheet close to point where pocketing of crown sheet occurred was not affected.

Appurtenances Fitted to Locomotive

The locomotive was equipped with a Franklin pneumatic fire door which was torn off at the time of the explosion. It was also equipped with a standard stoker, which was badly damaged, but still adhered to the running gear.

The boiler was equipped with three gage cocks applied in the water column, this column being located on the right side of the back head, closely adjacent to the right water glass, but not connected to it. The column was broken off flush with the back head but openings through the broken parts were clean.

The boiler was equipped with two water glasses, both of which were torn off, the bottom cocks being applied to the back head with top connections applied in the wrapper sheet about $5\frac{1}{2}$ inches forward from the knuckle of the back head. The openings of both water glass connections in the boiler were clean. The right water glass mountings and bracket were found a short distance from the boiler. Left water glass mountings were broken off at the boiler but still adhering to bracket attached to the boiler. Both stems to right water glass cocks were badly bent and damaged. The bottom water glass cock when found was open approximately one turn. The upper cock was open approximately two turns. The openings in mountings to right water glass were clean.

The stems of the left water glass cocks were broken off at the packing nuts and to determine the openings of valves the mountings were sawed apart. The lower valve was found to be nearly seated on one side of the valve and a slight opening found on the opposite side, which would make a very sluggish movement of water in glass and would not require very much sediment to obstruct the entire flow of water through this valve. The opening in the left top water glass mounting was found approximately two turns open.

There was a small piece of gasket rubber hanging loose in the stuffing box to the lower water glass cock of left water glass when same was inspected.

The lowest readings of water glasses and gage cocks were checked on locomotive 3,204 of the same class without leveling the boiler and found to be as follows: Right water glass $4\frac{1}{4}$ inches, left water glass $4\frac{1}{2}$ inches and the lowest gage cock 4 inches above the highest point of the crown sheet.

The stems of all gage cocks were broken off at the packing nut and the gage cocks were removed from the column and dismantled to determine their condition and were found clean.

The water column was also examined and found clean.

The condition of gage cock dripper could not be determined on account of the dripper being filled with clay and pipe broken off and not found.

The steam gage was demolished and could not be tested.

The condition of the right boiler check could not be determined on account of the boiler lying on its right side and the check could not be removed, the boiler not having yet been picked up by wrecking crane.

The left boiler check was examined and found in good condition and had $\frac{3}{8}$-inch lift. Both boiler checks were equipped with angle stop valves to boiler. Left check was found open, condition of right check not determined.

Condition of Tank

The tank was inspected and found practically clean. Tank wells were equipped with perforated strainers which were found clean. Both tank valves are of the plug cock type, and when inspected right valve was found clean and open, left valve was found clean and closed. Tank hoses were new and in good condition. Strainers used in strainer boxes in feed water pipes were clean. Hancock non-lifting inspirators size 11 were used. Right number 419,452 was damaged so that it could not be tested under steam, but was dismantled and all tubes and valves found in good condition except forcing tube, which was broken, and stem on steam valve which was also broken, no doubt from force of explosion. When inspected, steam ram to right inspirator was found open. Left No. 419,879 was applied on locomotive 3,204 of

(Continued on page 326)

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The double event during the week of December 3 to 8 of the annual meeting of the American Society of Mechanical Engineers and the Power Exposition to be held at the Grand Central Palace, New York City, will give those interested in the design and construction of boilers an opportunity to check up the year's developments in the field of power.

During the week the Power Test Codes Committee will hold public hearings on the Code for Stationary Steam Generating Units and on the Code for Locomotives at both of which the work of the committee will be open to general discussion.

The recent annual meeting of the National Safety Council, held at Buffalo, N. Y., brought home to delegates from every important industry, insurance company and railroad in the country the necessity of decreasing the number of accidents that every year take their toll of lives from the man-power of the country. In 1922, 75,000 men, women and children were killed in accidents, many of which might have been prevented by the application of the ordinary rules of caution and safety that have been laid down for practically every branch of industrial and civil activity and occupation.

There are now fifty organizations in as many cities spreading the gospel of safety with excellent results. It is a significant fact that of all promoters of the safety idea the railroads have accomplished more than practically any other industry in lessening the fatalities caused by the pursuance of its function in the community.

Railroad shops and boiler shops in general have been leaders in the safety movement, but resolutions applying to industry adopted by the Safety Congress and given below indicate ways and means for further promoting industrial safety.

"The safeguarding of all dangerous machinery and places in industry and elsewhere according to standard methods of proved value.

"The development of industrial equipment and processes along lines of inherent safety for the double purpose of eliminating accident hazards and increasing production efficiency.

"The education of all workmen and their supervisors in safe methods and habits of work."

Reports from the Far Eastern division of the Department of Commerce indicate that rebuilding operations in Japan will be extended over a period of from five to seven years. This activity will be accompanied by a steady demand on outside sources of supply for construction materials, machinery and power units. Plans and specifications for the rebuilding of the affected areas are now under way, and at this time the budgets for the necessary work are being considered by the Japanese Diet.

The opportunity for American manufacturers to supply a great deal of the material required for reconstruction is great—particularly heavy machinery, factory equipment and boilers. Here is an opening to manufacturers in this country with stock boilers on hand to supply a foreign demand in which the time factor is vitally important and, at the same time, establish a firm foundation for future business.

The financial condition of Japan is generally satisfactory, so that with the insurance adjustments that will be applied towards the purchase of equipment American manufacturers can feel secure on the question of credit.

The United States Department of Commerce in Washington will supply details of industrial requirements in Japan.

Notice has been received by C. W. Obert, secretary of the American Society of Mechanical Engineers' Boiler Code Committee, 29 West 39th street, New York, that the new boiler regulations for India are now in the final stage. Copies of these regulations will be received in this country within a short time, and will be published in THE BOILER MAKER. They will be particularly interesting to American boiler manufacturers who, it is suggested, should exercise discretion in the meantime in meeting stock orders from agents in India, especially if these stocks are liable to be unsold by January 1, 1924, when the new regulations will go into force. This, of course, assumes that such stock sizes will not meet the new conditions imposed.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Plate Bending Roll for Heine Boiler Shop

THE Hilles and Jones Works of the Consolidated Machine Tool Corporation, New York, has recently completed an exceptionally large boiler plate bending-roll to be installed in the St. Louis shop of the Heine Boiler Company. This No. 9 bending roll is a new and improved heavy-duty hinged-housing machine, designed for handling plates up to 1⅝ inch thick and rolling these to relatively small diameters.

The distance between the housings is 26 feet 6 inches to provide ample length for rolling plates 26 feet long.

The machine is provided with two interchangeable upper rolls, the larger upper roll 36 inches in diameter and the smaller 30 inches in diameter. The 36-inch upper roll is used when rolling the heaviest plate and to ordinary diameters, while the 30-inch upper roll is used when rolling plates to small circles of about 36 inches diameter. The lower rolls are each 22 inches diameter, and the roll journal-bearings in the housings are bushed with bronze.

The roll forgings proper are all made of open hearth forged steel, and the upper rolls have a solid forged extension which provides for counterbalancing when the back housing is dropped down for the removal of plates rolled to full circles.

The rated capacity for the machine is a pressure of 2,500,000 pounds, this being a very conservative rating as the factor of safety is high.

The housings and all driving gears are steel castings. The housing bed plates and gearing bed plates are semi-steel castings of box section design.

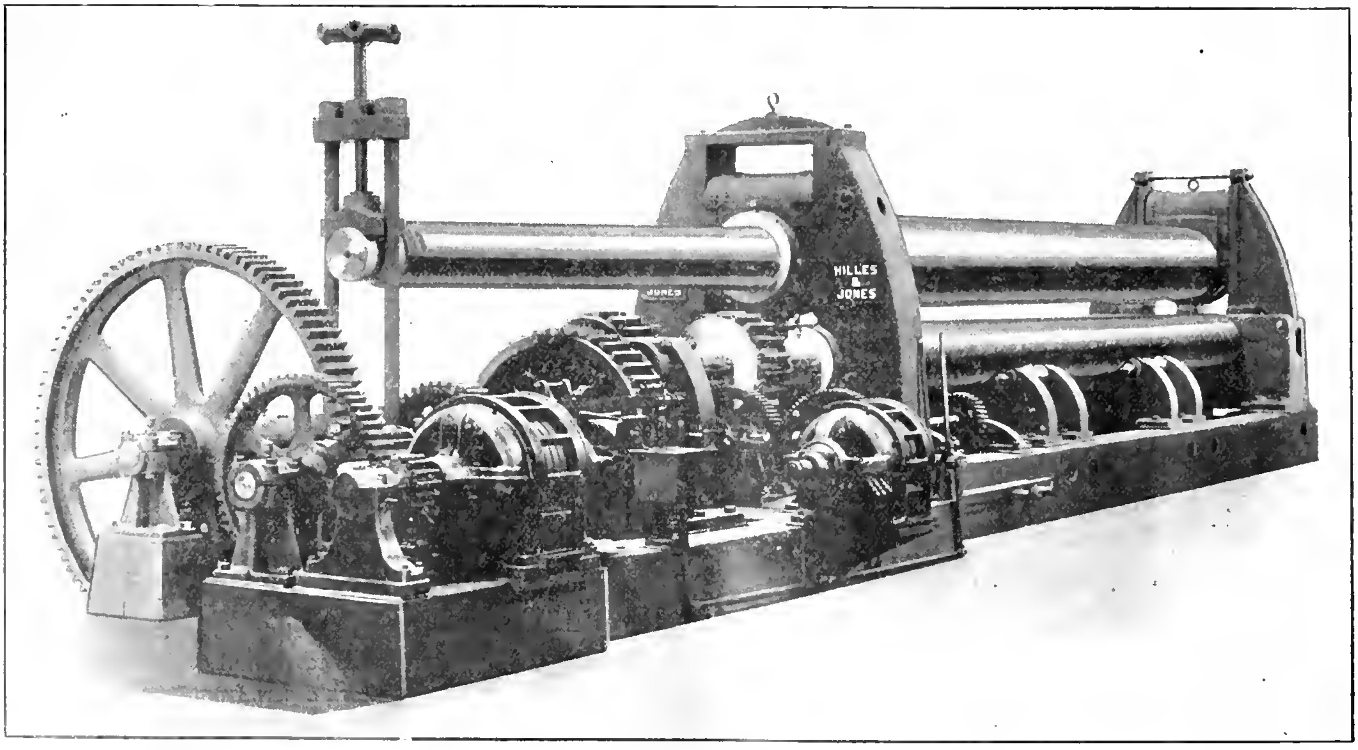
The upper roll is supported from the roll necks which are fitted in trunnions having bearings bushed with bronze. The trunnions are carried in yokes, the back yoke being a steel casting while the front yoke, which supports the upper roll when counterbalanced, is a steel forging machined to shape. The raising and lowering of the roll is secured through a worm and worm wheel drive, and is designed so that both ends of the upper roll may be raised or lowered simultaneously or one end held stationary while the other end is raised or lowered.

This arrangement for operating the upper roll is necessary in rolling plates to conical shapes, and is often found advantageous in ordinary boiler shop practice. The worms are of machined cast bronze and run in enclosed bearings designed so as to provide for lubrication with either heavy oil or grease. The worm wheels meshing with the worms are made of cast steel and have teeth cut from the solid metal.

The driving pinions on the lower roll necks are steel castings shrouded to the pitch line. These pinions are both driven from a wide-faced cast steel gear shrouded to the pitch line and this driving arrangement conveys power directly to both lower rolls.

The machine is geared for two speeds—a slow speed for handling the heavier plates and a high speed for handling lighter plates. The control of the speeds is by hand levers direct connected to positive clutches.

Two substantial roller supports are provided for the lower



Hilles and Jones Bending Roll Specially Built for Boiler Work rolls and each support carries four forged steel rollers finished to 7 15/16 inches diameter. The rollers are carried in closed end bearings which design provides for lubrication of the rollers by means of large grease cups. This arrangement not only insures lubrication but also keeps scale and dirt from clogging and stopping the action of the rollers.

All high-speed shafts have bearings bushed with bronze and substantial outboard bearings are provided to carry the outer end of all driving shafts so that there are no overhanging gears.

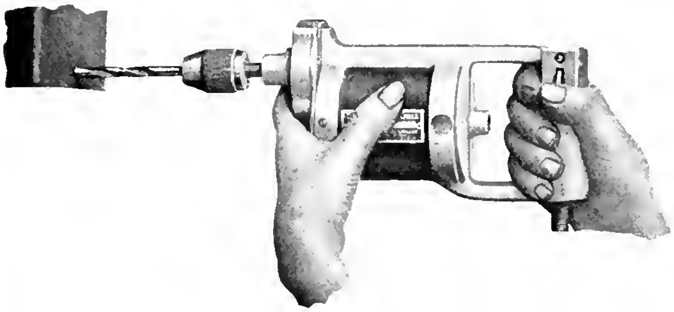
The machine is operated by two motors, a motor of 125 horsepower is used for driving the lower rolls and a motor of 60 horsepower for raising and lowering the upper roll. The weight of the machine is 415,000 pounds.

The need for a tool of this sort arises from the increasing demand for exceedingly high pressure boilers of large capacity, requiring the use of thick plates in large sizes for the cylindrical shells. The possession of equipment of this sort will enable the Heine Boiler Company to accept and promptly execute orders for large capacity high pressure boilers of any of the several types which it builds.

Light Weight Electric Drill

THE electric drill illustrated, which weighs less than five pounds, has been placed on the market recently by the Argyle Railway Supply Company, Chicago. This tool will drill holes up to 3/8 inch in diameter and is said to be practically non-stallable. It is well adapted for many drilling operations in railroad shops, including stay bolt tell-tale holes, miscellaneous drilling in car repair work and battery work. A special Westinghouse motor is used which will operate on either alternating or direct current, the motor running at high speed on light loads and slowing down to the required amount when drilling larger holes. The free speed is 2,000 revolutions per minute and the full load speed 850 revolutions per minute which is approximately the proper cutting speed for a 3/8-inch drill.

The field windings are coated with a special compound and baked 90 hours, resulting in a field coil of one solid mass



The Titan Electric Drill is Convenient to Handle and Operate

with practically no possibility of the wires becoming loosened from each other. This adds to the insulation properties, making the armature practically indestructible except from accidental mechanical abrasion. The armature is not injured by immersion either in oils or in water except as this might corrode the metal parts.

The ventilation of the drill brings the cool air into the back both in the upper and lower branches of the handle, assuring that the handle grip will always remain cool and that the incoming air will be distributed to all parts of the motor. The motor field is held away from the housing by ribs which permit the air to pass around that and also around the armature to cool these parts in the most effective manner. The air is discharged in the front of the housing, tending to blow away from the drill any dirt or particles which might be raised in drilling operations.

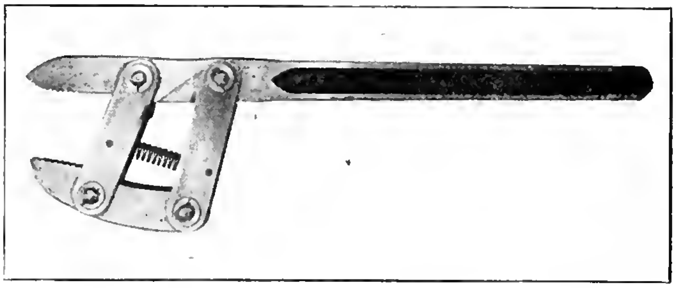
The Titan drill runs only when the operator is actually gripping it and drilling. The position and operation of the switch is natural and the ease of release without shifting the hand makes it possible to stop the motor without shifting the position of the drill, a frequent cause of breakage. This switch was developed for the Titan drill by the Cutler-Hammer Manufacturing Company. The drill is steel armored, designed to be non-breakable, and all parts are riveted together so that there is no danger of the contacts becoming loosened or the plug becoming broken. A durable cord is used which does not lead into the motor itself and can therefore be replaced without the services of an experienced electrician.

A simple and effective lubricating system is used, the two armature bearings and the drill chuck bearings having bronze bushings and spring oilers which retain a considerable amount of lubricant. If the drill is thoroughly oiled for the first few hours of operation it is said to require lubrication only occasionally thereafter.

The thrust in drilling is taken up on a ball-bearing, working between two hardened and ground steel surfaces. The gears are packed in grease. The pinion is of steel, cut directly on the armature shaft and meshing with a bronze gear. The teeth are cut helical, adding to the strength and smoothness of operation. The gear ratio is 7-5 1/2 to 1. This odd number is chosen purposely to prevent the same pair of teeth on the gear and pinion always meeting. The chuck is of the Goodell-Pratt keyless type requiring no tool to open or close it. To prevent the armature from turning when opening or closing the chuck, it is only necessary to press the spring stop into the slot in the end of the armature shaft and the chuck may then be turned without offering any difficulty.

Self-Adjusting Wrench

A NEW wrench, known as the "Roberts" type, which does away with the usúal screwing up and down adjustment by means of a set screw to make it fit an object, has been put on the market by the Greater Service Electric Company, Newark, N. J. Using only one hand with the new wrench, it is simply necessary to place it over



New Wrench with Quick Adjustment Feature

the object and it grips instantly. It is stated that the wrench never slips—the harder it is pulled the stronger it grips, and at any angle It also works with a new ratchet action which makes it easy to work in tight places.

The wrench is drop forged from high speed carbon steel. In its present 12-inch size, this wrench will handle any shape article from small nuts to one inch pipe. Its price is lower than the average good wrench, and the company states that the time saved by a mechanic in an ordinary day's work would pay for the tool. It is also guaranteed against all imperfections.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

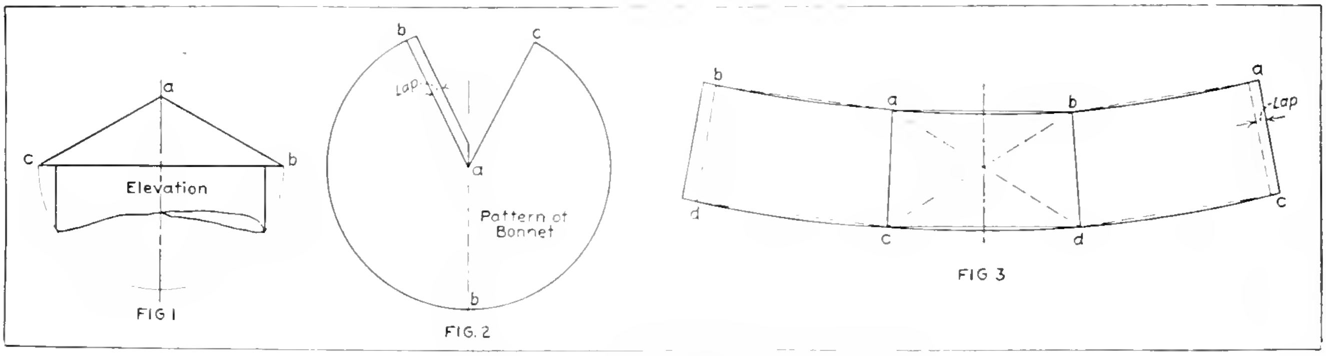
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Stack Bonnet and Tapering Casing

Q.—Will you kindly publish how to develop a stack hood or bonnet, and how to layout in one piece a sand dome casing?—S. C. D.

A.—The layout of a stack bonnet is shown in Figs. 1 and 2. Reproduce the elevation to the required dimensions, which shows the bonnet in the form of a cone. With the dividers or trammels set to a radius equal to *a-b*, Fig. 1 draw a circle as from point *a*, Fig. 2. Make the arc lengths between *b-b* and *b-c*, Fig. 2 each equal to the length of the semi-circle, Fig. 1. which may be done by using a circular measuring wheel. If such an instrument is not available space one-half of the semi-circle into equal parts and use the arc lengths for spacing off the stretchout in the pattern. The circular length around the base of the cone, Fig. 1, equals the product of the diameter and 3.1416. Thus, if the diameter *b-c* equals 14 inches, the circumference of the base equals 14 × 3.1416 = 43.98 say 44 inches, to which must be allowed material for the lap.

Fig. 3 shows a short and an approximate method for developing a frustum of a cone when the taper is very small. Lay off an elevation of the frustum *a-b-c-d* and on each side reproduce an additional one, thus locating four points as *b-a*, *b-a* at the top and *d-c*, *d-c* at the bottom for drawing in the camber lines. A pliable piece of bar or strap iron or batten may be placed on these points and the camber lines drawn in. Make their lengths equal to the circumference of the upper and lower base circles and allow for lap. A traveling wheel can be used for measuring these lengths.



Stack Hood Layout and Frustum of a Cone

Renewing Side Sheets and Tubes

Q.—Please tell me how to put on ⅜ side sheets which are now usually required over a fire; that is, how to get the holes spaced in the new sheet and the holes in the boiler spaced. Some of our repair boiler makers lay off the holes in the boiler and have them drilled while getting out new ones at the shop; others put holes in the new sheet and lay off from that to the boiler, which is slow but sure. Others do not know how much lap to give. Also please tell me the best system of taking out flues of vertical and other boilers, which is usually the main repair work.—M. E. H.

A.—In applying side sheets or new sections of side sheets, two methods are applicable. Some repair men remove the damaged section, using the oxygen torch for cutting where possible without damaging the outer firebox sheets. The old plate is straightened and used as a template for marking off the new patch. The edges of the plate after cutting with the gas torch are left with a crust which must be scraped or chipped off.

Overlapping edges at the corners of the patch should be thinned down by scarfing. The stayholes in the new patch should be punched smaller than the required stay diameter and afterwards reamed out in place to insure alinement of the stays. Rivet or patch bolt holes can also be drilled out in place. The lap around the seams should equal 1 inch. Where the top seam is not subjected to stress, it may be welded as that construction avoids overlapping plates, which waste away on the fireside.

LAYING OUT SHEETS

In Fig. 1 is shown an end view (a) and side view (b) of a wagon top firebox in which the side sheets *A* are riveted to the crown sheet *B* at *C*. Where such drawings are available for the boilers to be repaired the dimensions given should be checked for any changes that may have been made. From the drawing the new side sheets can be laid off to the dimensions given, and the new sheet fabricated while the old one is being removed. Care in handling this work must be taken to insure accuracy as the slightest variation in rivet or stay spacing will result in a loss of the plate.

Where a firebox is made up in the way shown in the illustration, it is advisable to renew the entire side sheet, as this overcomes the need of two lapped seams.

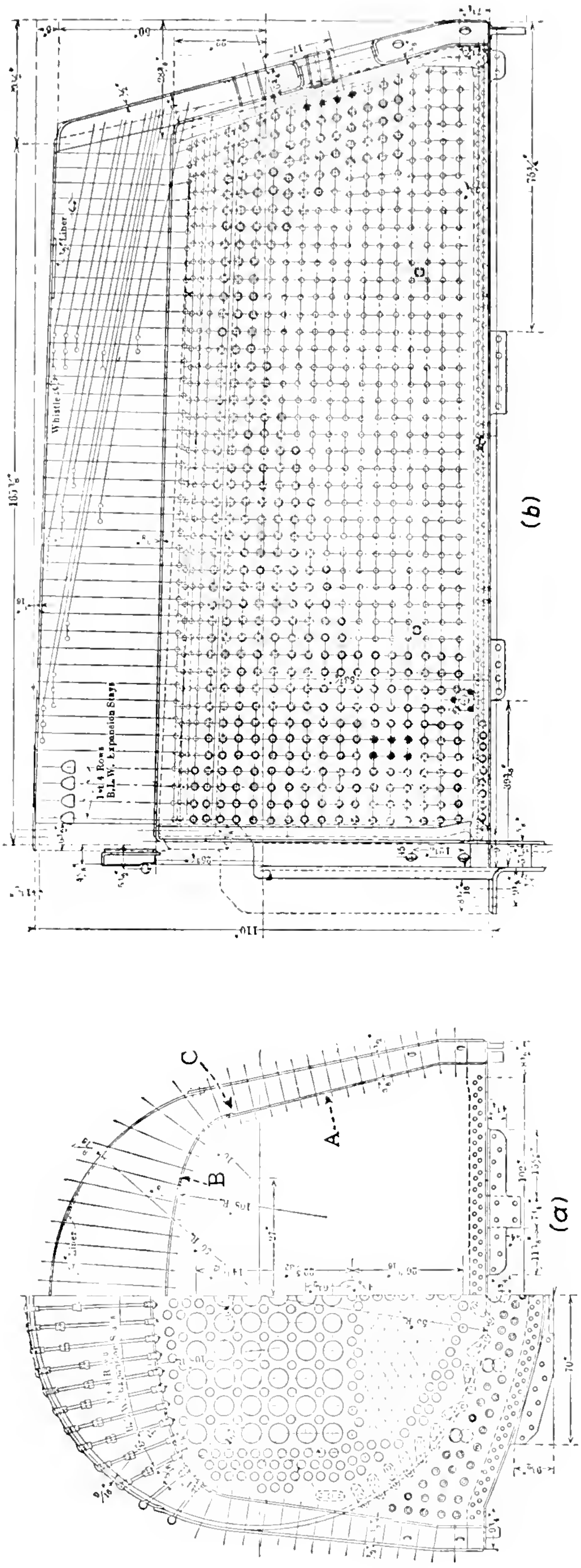


Fig. 1.—End and Side Views of a Wagon Top Type Locomotive

Removal of Defective Tubes from the Sheet

The methods followed in such work depend somewhat on the type of boiler; in general firetubes are removed by first cutting off the bead around the tubes and then to split the tube back 1 or 2 inches with a cape chisel or a rectangular tool called a crosscut. The split end of the tube is then flattened on itself at each end so that it can be drawn through the tube hole.

Fig. 2 shows a view of a tube and the method of splitting it; a tool of the form shown in Fig. 3 is then driven between the tube and plate forcing the split ends together as shown in Fig. 4.

Where an entire new tube installation is required and if the tubes can be removed through the manhole at the top or bottom of the boiler, the tubes can be readily cut out with a tool of the form shown in Fig. 5. The heel of the tool rests on the tube sheet and the lever arm *a* is brought down causing the cutting edge *b* to tear and cut out the tube, thus completing the operation.

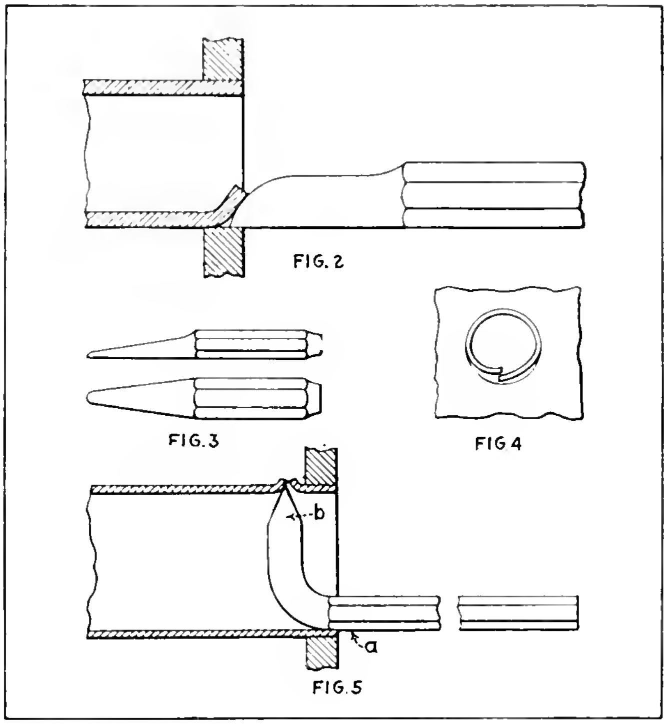


Fig. 2.—Method of Splitting Tube. Fig. 3.—Tool for Forcing Split Ends Together. Fig. 4.—Split Ends after Forcing. Fig. 5.—Tool for Cutting Tubes

There are several good rotary tube cutters used in cutting off the tubes, and by their use considerable time and labor is saved.

Method for Removing Large Oil Tank Bottom

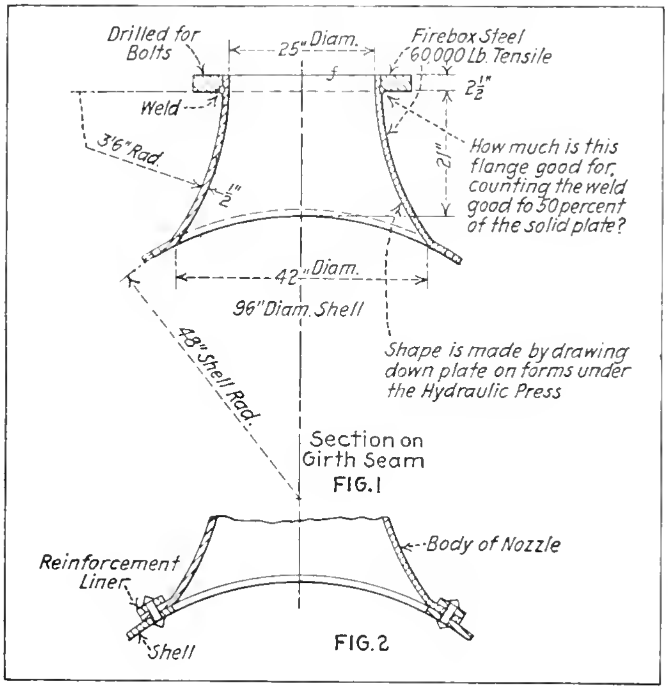
Q.—Would you please inform me as to the proper way to take out and replace a new bottom on a 90-foot steel fuel oil tank with regard to saving time on the job.—A. V. J.

A.—As in all repair work, the best means of handling a job depends on the conditions under which the repairs can be handled. In this case, we cannot give definite information, since we do not know how the tank is situated for carrying out such a major repair. If you will give further data we shall be pleased to help you, if possible, in an early issue of the magazine.

Pressure on Nozzles

Q.—How can I calculate the pressure which the large steel nozzle as shown in the sketch will stand safely; that is, what working pressure, or how thick to make the nozzle to stand a certain pressure. The tensile strength of the steel is 60,000 pounds per square inch and is firebox grade, so as to flange easily on a four post press. The finished thickness is ½-inch after pressing and drawing down to final shape. The shape is just the same as the standard "Taylor" or American Spiral Pipe Company's regular design of nozzles as used on A. S. M. E. boilers. What is the rule used for these smaller size nozzles? These nozzles are drawn from one round plate and without seams or welds, like the smaller ones mentioned. For 100 pounds pressure do you think any reinforcement is required for the outside of the rivet flange as shown in Fig. 2? If so, how should the reinforcement be figured?—C. P.

A.—To my knowledge there is no formula for finding the allowable working pressure on the nozzles shown in Fig. 1. A close approximation is the truncated cone formula given



Details of Boiler Nozzle

in Par. 231 of the A.S.M.E. Boiler Code. In the use of new constructions of this kind, the procedure is to make special tests of several samples, and record all deflections as the pressure is applied. Manufacturers of nozzles of smaller sizes have done this, from which standard sizes for different working pressures have been adopted. These data are given in the A.S.M.E. Code in tables of flange fittings; which cover those made of cast iron. An allowable variation of 20 percent from the flange thickness given in these tables may be made for cast steel and forged steel fittings; leaving the drilling for bolt holes unchanged. For pressures above 250 pounds per square inch, the flange thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittings.

Nozzle Connections

The connection of the nozzle to the shell comes under the rules applied to dome connections. The A.S.M.E. Code specifies in Par. 194 the following: When the maximum allowable working pressure exceeds 100 pounds per square inch the flange of a dome 24 inches or over in diameter shall be double riveted to the shell. The flange of the nozzle tends to stiffen and compensate for the loss in strength of the shell, due to the removal of the plate for the nozzle opening. A reinforcing liner should be provided and riveted to the inside of the shell. Such reinforcements may be calculated as explained for manhole reinforcements or liners; as given in Par. 261 of the A.S.M.E. Code. No reinforcement is needed as you have shown in Fig. 2

BUSINESS NOTES

The Blacker Engineering Company, Incorporated, Grand Central Terminal, New York City, manufacturer of Blacker blacksmithing hammers, have opened an office in Pittsburgh at 421 Wood street with George Hesse as district manager.

The Linde Air Products Company, New York, recently started continuous operations in its new plant at Tulsa, Okla. Oxygen will be extracted from the air by the liquefaction process. The plant is also able to reclaim the nitrogen and separate the rare gases, argon and neon. C. A. Kennedy is operating superintendent. A Prest-O-Lite plant, for the manufacture of welding and cutting gas, is also planned for the same locality.

The Industrial Works, Bay City, Mich., which was established in 1873, celebrated its fiftieth anniversary on October 13, at Bay City. The celebration included a sales conference of all representatives of the Industrial Works from all principal points of the United States, Canada, Cuba and South America. Another feature was a test of a 200-ton wrecking crane which had been built for the Norfolk & Western. The Industrial Works was started in 1873 with a working force of 30 men in a factory building 75 by 100 feet. The plant today covers 29 acres of ground, and includes 59 buildings with 440,000 square feet of floor area, 5 miles of railroad track and employs 1,800 men. The 59 buildings include a foundry and pattern, blacksmith, boiler, bucket, car, canopy, electrical, paint, pipe and machine shops, each of which is a complete unit. Besides there is a pattern storage building, an employees' restaurant, a garage, and an office.

Charles Piez, president of the Link-Belt Company, Chicago, announces the purchase of the Meese & Gottfried Co., of San Francisco, Los Angeles, Seattle and Portland. For the past ten years Link-Belt Company has been distributing its products on the West Coast through its subsidiaries, the Link-Belt Northwest Company, of Seattle, and the Link-Belt Pacific Company, of San Francisco. The improvement in distributing facilities effected by the consolidation, and the additional manufacturing facilities acquired, should give the rapidly-growing industries of the Pacific Coast highly economical and efficient service. The new organization will be known as Link-Belt Meese & Gottfried Company, with headquarters at San Francisco. The officials will be: Charles Piez, chairman of the board; B. A. Gayman, president; Harold H. Clark, vice-president and sales manager; Leslie W. Shirley, treasurer; Richard W. Yerkes, secretary.

The Mahr Manufacturing Company of Minneapolis, Minn., manufacturers of rivet forges, torches, furnaces and kindred oil burning equipment, has moved its New York office from 56 Murray street to larger quarters at 42 Murray street. Ray G. White is the direct representative of the company at New York.

The Westinghouse Electric & Manufacturing Company at their South Philadelphia Works has established a General Engineering Division which will be devoted to the study of central station and industrial plant problems, which involve the application of steam power apparatus such as steam turbines, condensers and reduction gears. This department will also co-operate with the sales organization in providing engineering service to purchasers of this equipment.

The main office in Tokio, Japan, of Roku-Roku Shoten having been destroyed, requests are made to manufacturers in the United States to send to the company's branch office at Osaka, street address Enokojima Nishiku, complete catalogs and prices to replace their files. S. Noda is president of the company.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Firebox Wreckage after Great Northern Locomotive Low Water Explosion

Locomotive Boiler Explosion Caused by Low Water

On April 9, 1923 a serious and unusual locomotive boiler explosion occurred near Roach, North Dakota, about twenty-five miles west of Minot, on the main line of the Great Northern Railway. Three men lost their lives in this explosion; the brakeman was killed instantly, the fireman died while being taken back to Minot and the engineer died the following day at a hospital.

This locomotive, No. 3201, one of the largest and newest, built for heavy freight service on the G. N. line, was one of several of its type built during the war while the roads were under government control. It left the Minot terminal on its fateful trip west at about 3 P. M. April 9 and two hours later the shocking news reached Minot of the disaster, with the casualties above mentioned. This boiler was subjected to a hydrostatic test just shortly before the explosion and was carefully inspected on the fateful day before leaving the Minot roundhouse by a federal inspector, who happened to be present on that day.

Examination of the firebox showed that the crown sheet had been badly burnt and all other indications showed that the explosion was caused by low water in the boiler; the engineer, however, who remained conscious until he died, emphatically denied this and stated that the water glass registered not less than two inches just two minutes prior to the explosion.

The railroadmen of Minot would be glad to receive a more complete and detailed report of this accident, and those of us who are subscribers to The Boiler Maker have been eagerly watching the magazine but no report has so far appeared.

Minot, N. D. — Ed. Dingfield.

Editor's Note: The official report of the Bureau of Locomotive Inspection dealing with this disaster appears on page 317 of this issue.

Failure to Live Up to Construction Rules a Source of Unfair Competition

The Boiler Code was submitted to us by the A.S.M.E. and the commissions appointed by the different states as a rule and guide for the construction of boilers.

Recently I was in a shop and investigated the class of work and conditions under which boilers were being built at this particular plant and I will say that I am very much surprised and astonished at the class of work that was being allowed and let pass.

There was no excuse for such a poor grade of work except that the concern manufacturing the boilers was looking for production and to keep the overhead down, thereby constructing an inferior grade and class of boilers. I was at the shop for three and one-half days during working hours and I saw an insurance boiler inspector there three days, but never saw him make an inspection but merely take the melt number of the plates. He evidently does not follow up the construction and I am absolutely sure he does not make the concern comply with the Code requirements.

These are some of the interesting items that I saw but of course there were numerous others.

1. Sheets and butt straps were not taken apart and burrs and chips removed after drilling and reaming.

2. Flue beads were cracked but were hammered over to hide cracks and checks.

3. Holes in cross braces were cracked from rivet or bolt hole out.

4. Holes in barrel sheets were not drilled and reamed straight and some were out of alinement from 12 to 15 degrees.

5. Back head sheet around corner had a very bad crack at the scarf and was not properly welded.

6. Instead of calking sheets they were plugged straight back to fill up bad cracks and joints which were caused by not laying up the sheets and heads.

7. There was a heavy acetylene burr where the firedoor holes were burnt out and the sheets were bolted and riveted to the firedoor ring without removing the burr.

8. Staybolts and rivets were loose in the sheets.

9. Backhead braces were bent very crooked and allowed for unnecessary expansion.

10. Cross braces were loose and showed considerable slack.

11. Sheets were planed or milled or chipped as required by Code.

12. Sheets were not properly laid up before riveting. The mudring corners both inside and out were not laid up, nor the other sheets. In order to make a good job, it is necessary to heat these corners and lay up the material.

13. The sheets were not properly bolted. There was ½-inch space between the front flue sheet and the barrel seam when sent to the bull machine for riveting.

It is time some action is taken and the Code lived up to; for it is not right to make one firm build standard boilers and another party be allowed to put slip-shod work across for it is unfair competition and an injustice.

Olean, N. Y. Charles W. Carter, Jr.

Fatal Boiler Explosion Caused by Low Water

(*Continued from page* 318)

the same type and tested under steam and found in good condition.

Locomotive was equipped with four consolidated safety valves, open type, 3-inch diameter, numbers 27,644, 27,596, 27,701, and 30,998, which were removed and applied on locomotive 3,204 of the same type and tested and found to open at 182, 195, 202 and 211 pounds, respectively.

The boiler of locomotive 3,201 was washed April 14 and monthly inspection completed April 16 at Minot, N. D., and locomotive was performing first service after monthly inspection.

Left water glass tube was broken while spindles were being removed for cleaning at time boiler was washed and inspected and a new water glass applied.

The last monthly inspection of locomotive 3,201 was on April 16, 1923, at Minot, N. D.

Daily Inspection Reports

Work reports for locomotive 3,201 dated March 1, 6, 8, 24, 27 and 30 and April 1, 4 and 14, which were on file at Minot, were examined, but none contained defects which in our opinion may have contributed to accident except report for April 14 on page 2, where appears notation, "Water glass" M. Donsvar, which refers to water glass which was broken out and reapplied at time glass cocks were being cleaned.

Conclusions from Investigation

Several appurtenances were damaged so that condition prior to accident could not be determined.

The general condition of the locomotive was apparently good prior to the accident.

The crown sheet failure was caused by overheating due to low water.

The only special notation in the report is that treated water is used on this division and foaming of water in boiler is a common occurrence.

TRADE PUBLICATIONS

Hydraulic Riveters.—A four-page circular illustrating and describing Hanna hydraulic riveters has just been issued by the Hanna Engineering Company, Chicago.

Welding Cable.—Two announcements by the Rome Wire Company, Rome, N. Y., have been published describing special extra flexible electric welding cable and special-service cord. Many applications of these two types of cord, the first for welding outfits and the second for a variety of shop and household uses, are outlined.

Hydraulic Machinery and Power Tools.—"An Album of Engineering Achievement" is the title of a 64-page, illustrated catalogue recently issued by the Southwark Foundry & Machine Company, Philadelphia, Pa., featuring the wide application of Southwark hydraulic valves, accumulators, presses, intensifiers, power punches, etc.

Welding and Cutting Equipment.—The Torchweld Equipment Company, Chicago, Ill., has issued a new catalogue covering its complete line of oxy-acetylene welding and cutting apparatus, lead welding, soldering, brazing, decarbonizing units, gas pressure regulators, automatic machines, generators and supplies. The catalogue contains cross sectional views of equipment with detailed explanations.

Floor and Bench Grinders.—The two-wheel floor and bench grinders, manufactured by the Hisey-Wolf Machine Company, Cincinnati, O., are illustrated and described in detail in a new bulletin prepared by the company. Floor stand grinders are made in seven sizes ranging from ½ to 10 horsepower capacity, while the bench grinders are in two sizes of ½ to 1 horsepower capacity. The special features of these grinders are outlined with specifications and other details.

Charcoal Iron Boiler Tubes.—A 52-page brochure, citing a few instances of the high resistance of Parkesburg charcoal iron boiler tubes to corrosion and long service life, has been issued by the Parkesburg Iron Company, Parkesburg, Pa. Following a brief outline of the physical properties of charcoal iron and its corrosion resisting qualities, is an interesting illustrated story of the Parkesburg process of manufacturing boiler tubes from the charging of the forge fire to the final inspection and test of the finished product.

Boiler Feed Pump and Feed Water Heater.—The construction and operation of the Worthington locomotive boiler feed pump and feed water heater are clearly shown in colored diagrams in an attractive 16-page bulletin, B-1607-B, recently issued by the Worthington Pump & Machinery Company, New York. The heat and coal saving characteristics of the feed water heater are shown in curves. A table of the properties of steam is also given and examples illustrating its use in calculating the reduction in the amount of heat required to generate the steam, the amount of steam required for heating and the amount of water saved by the Worthington locomotive feed water heater.

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States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Allegheny Co., Pa.	Michigan	Oklahoma
Arkansas	Minnesota	Oregon
California	Missouri	Pennsylvania
Delaware	New Jersey	Rhode Island
Indiana	New York	Utah
Maryland	Ohio	Wisconsin

Cities

Chicago, Ill. (will accept)	Los Angeles, Cal.	Philadelphia, Pa.
Detroit, Mich.	Memphis, Tenn. (will accept)	St. Joseph, Mo.
Erie, Pa.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Omaha, Neb.	Scranton, Pa.
	Parkersburg, W. Va.	Seattle, Wash.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

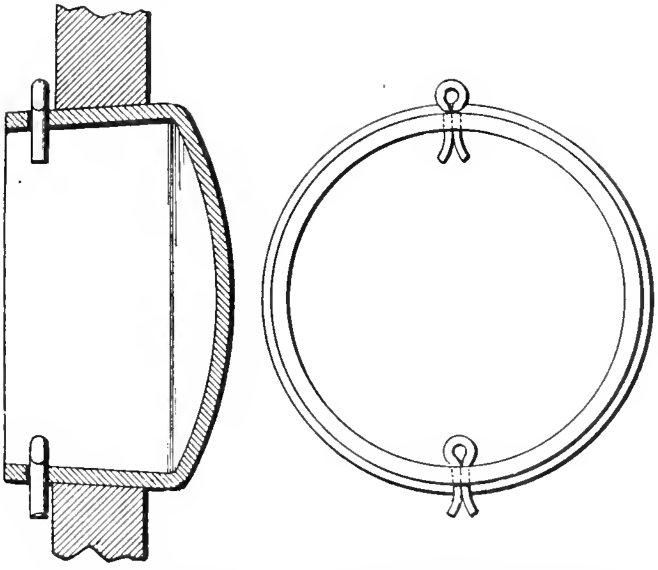
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,456,315. BOILER PLUG. FREDERICK E. KEY, OF ST. LOUIS, MISSOURI, ASSIGNOR TO KEY BOILER EQUIPMENT COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

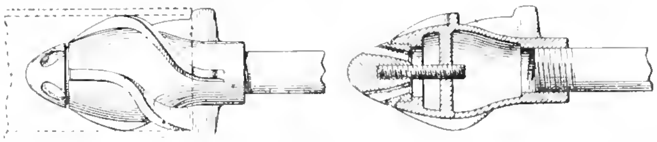
Claim 1.—A device of the character described, the combination of a wall member having a circular opening providing an annular plug-receiving seat, a hollow sheet metal boiler plug closed at its inner end and open at its outer end, said boiler plug having a smooth annular conico-cylindrical peripheral portion adapted to frictionally engage said annular seat, said



conico-cylindrical portion being so tapered as to decrease in diameter toward the open outer end of the plug so that the plug, acting like a check valve, may be forced into frictional engagement with its seat by outward pressure on its closed inner end, the annular open outer end portion of the plug being adapted to pass through and extend from said opening, and a safety device preventing accidental inward displacement of the plug from said opening, said safety device comprising a detachable retaining device extending entirely through the wall of the last mentioned end portion and projecting from the peripheral face thereof at a point in front of the outer face of said wall member to retain the plug in said opening. Two claims.

1,460,669. BOILER TUBE CLEANER. JOHN H. GOODFELLOW, OF BUFFALO, NEW YORK.

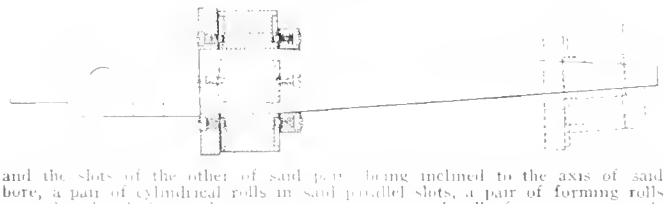
Claim 1.—A boiler tube cleaner comprising a hollow body, spiral flanges arranged in spaced relation on the outer face of said body, and a nozzle arranged at the front end of said body and provided with a plurality of



forwardly diverging jet openings for the passage of the cleaning medium therethrough, the outlet ends of said openings being flared and located in the sides of said nozzle and immediately in front of the spaces between said flanges. Five claims.

1,467,238. TUBE EXPANDER. JAMES T. DEMPSEY, OF NEW BEDFORD, MASSACHUSETTS.

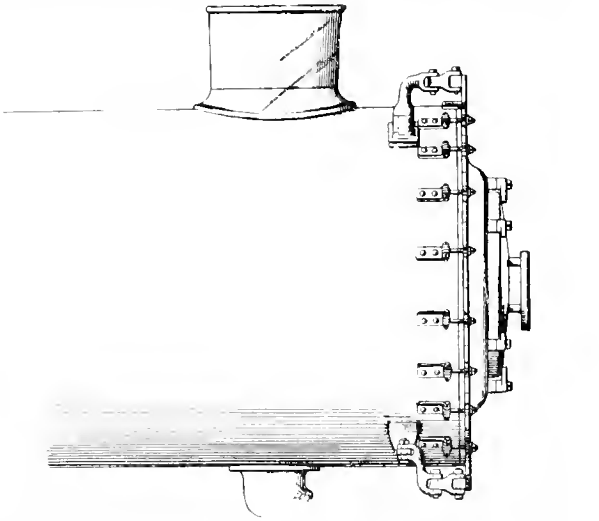
Claim 1.—A tube expander having, in combination, a head provided with a cylindrical longitudinal bore extending therethrough there being two pairs of diametrically opposed slots extending through the wall of said head, the slots of one of said pairs being positioned parallel to the axis of said bore



and the slots of the other of said pair being inclined to the axis of said bore, a pair of cylindrical rolls in said parallel slots, a pair of forming rolls in said inclined slots and means projecting into said rolls from opposite ends of their respective slots and adapted to loosely position and retain said rolls in their respective slots. Two claims.

1,461,315. LOCOMOTIVE SMOKE-BOX FRONT. ARTHUR T. KUEHNER, OF ELKRIDGE, MARYLAND.

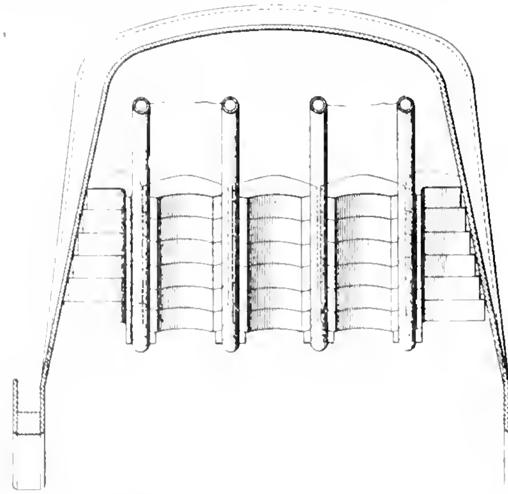
Claim 1.—The combination with a locomotive, and a smoke box front closing the smoke box of the locomotive, of a series of mating plates extending around the peripheral margin of the front and forming a reinforcing



ring thereon, means coacting with certain of said plates for detachably securing the front in position, and means adapted to extend between the smoke box and certain other oppositely disposed plates for pivotally supporting the front whereby the front may be swung to one side. Five claims.

1,468,908. LOCOMOTIVE ARCH. CHARLES E. MILLER, OF CHICAGO, ILLINOIS.

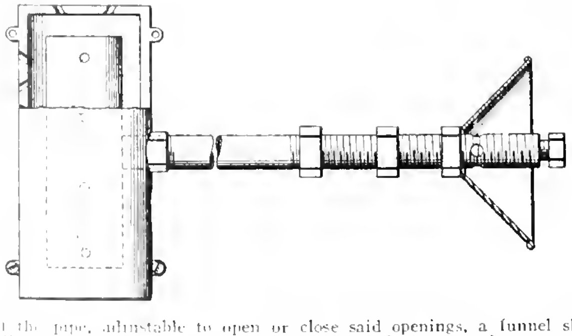
Claim 1.—In a locomotive arch, the combination with arch tubes and side sheets, of bricks laid upon and closing the space between adjacent tubes,



and an L-shaped brick having arms of unequal length the short arm extending vertically and resting upon an outside arch tube and the long arm extending horizontally and abutting a side sheet. Four claims.

1,465,502. AIR-FEEDING ATTACHMENT FOR FURNACES. HARRY W. WEAVER, OF ALLENTOWN, PENNSYLVANIA.

Claim.—An air feeding device for furnace doors comprising an externally threaded pipe extending through said door, the outer part of the pipe having air inlet openings in the side walls thereof, a screw plug in the outer



end of the pipe, adjustable to open or close said openings, a funnel shaped air collector screwed on the outside of the pipe, between said openings and the door, nuts on the pipe, clamping the same to the door, an outer perforated chamber having screw threaded engagement on the pipe, inside the door, and an inner perforated chamber, also screwed on the inner end of said pipe, inside of said outer chamber.

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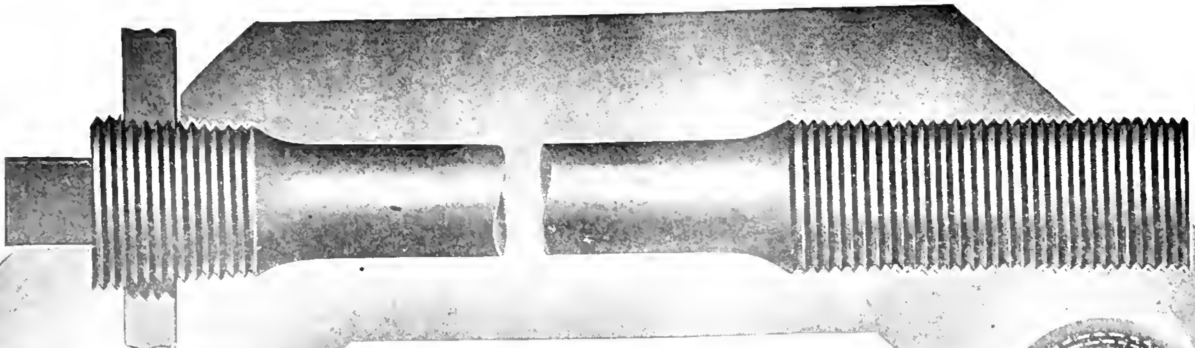

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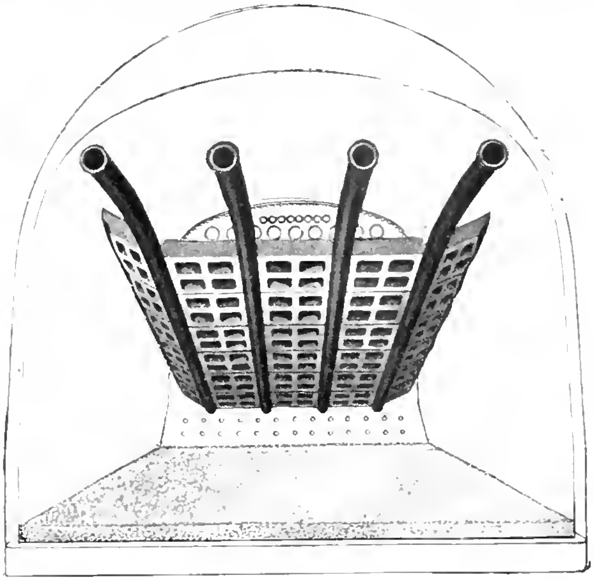

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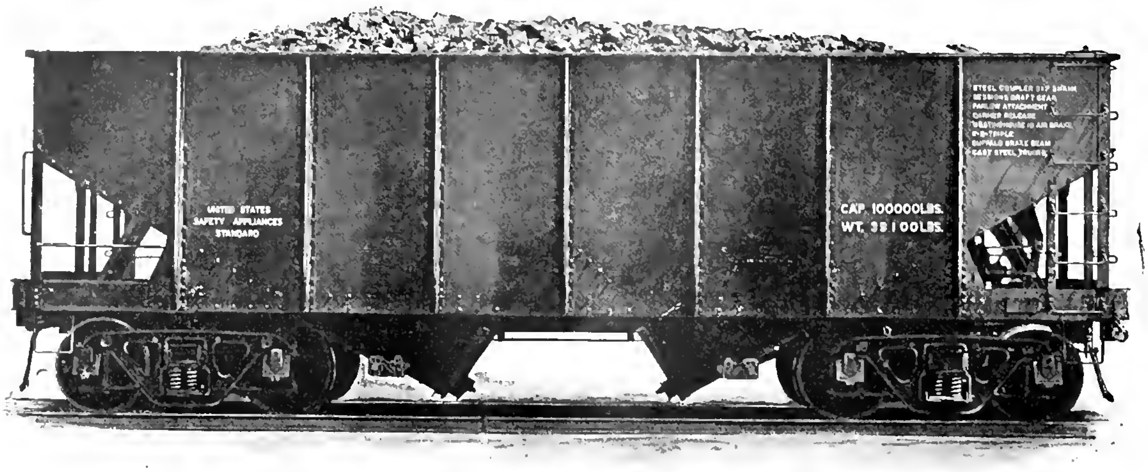

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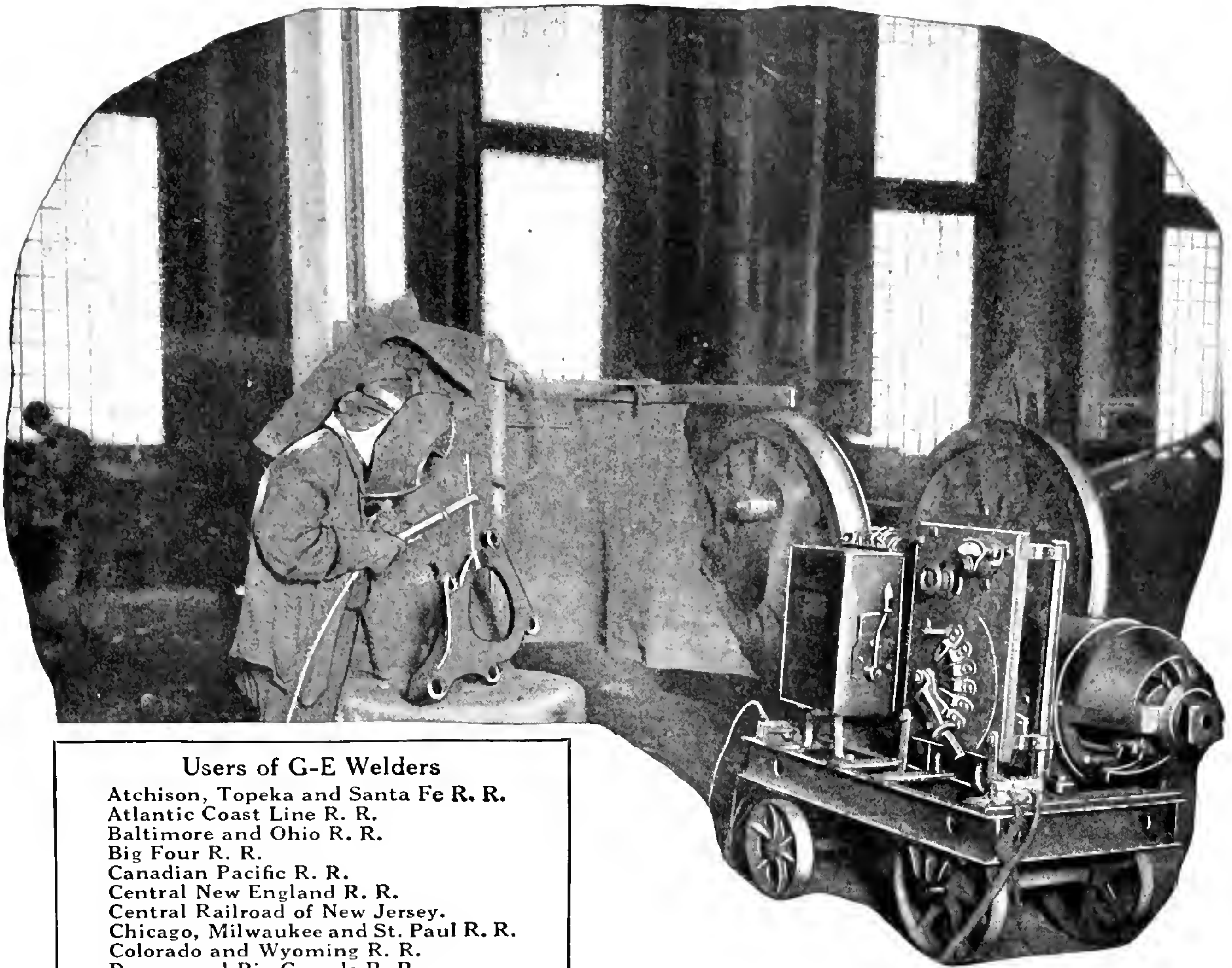

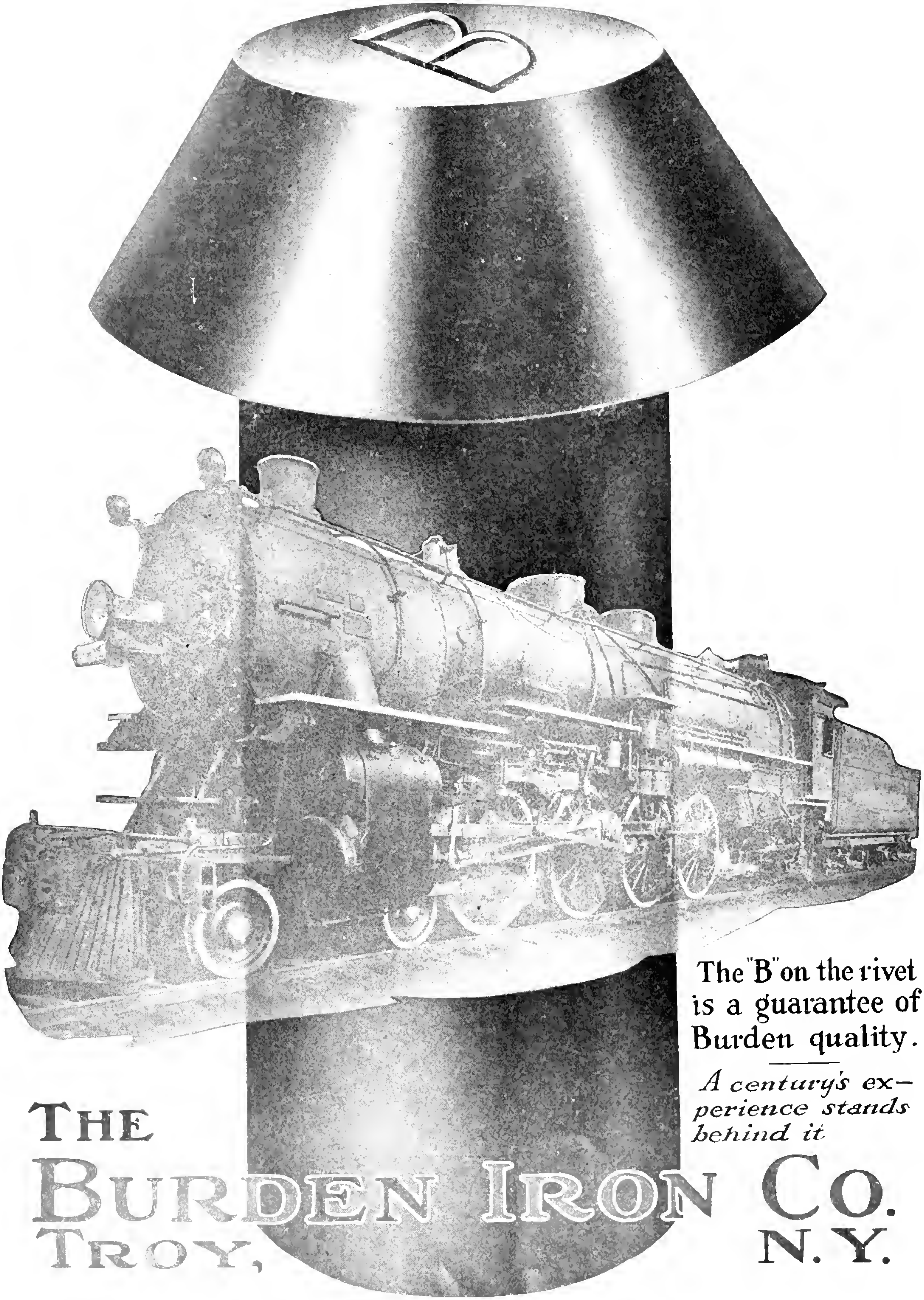
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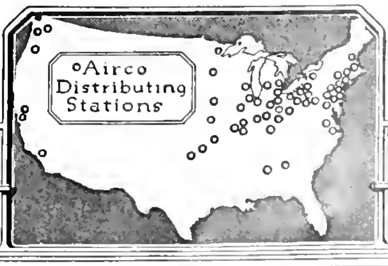
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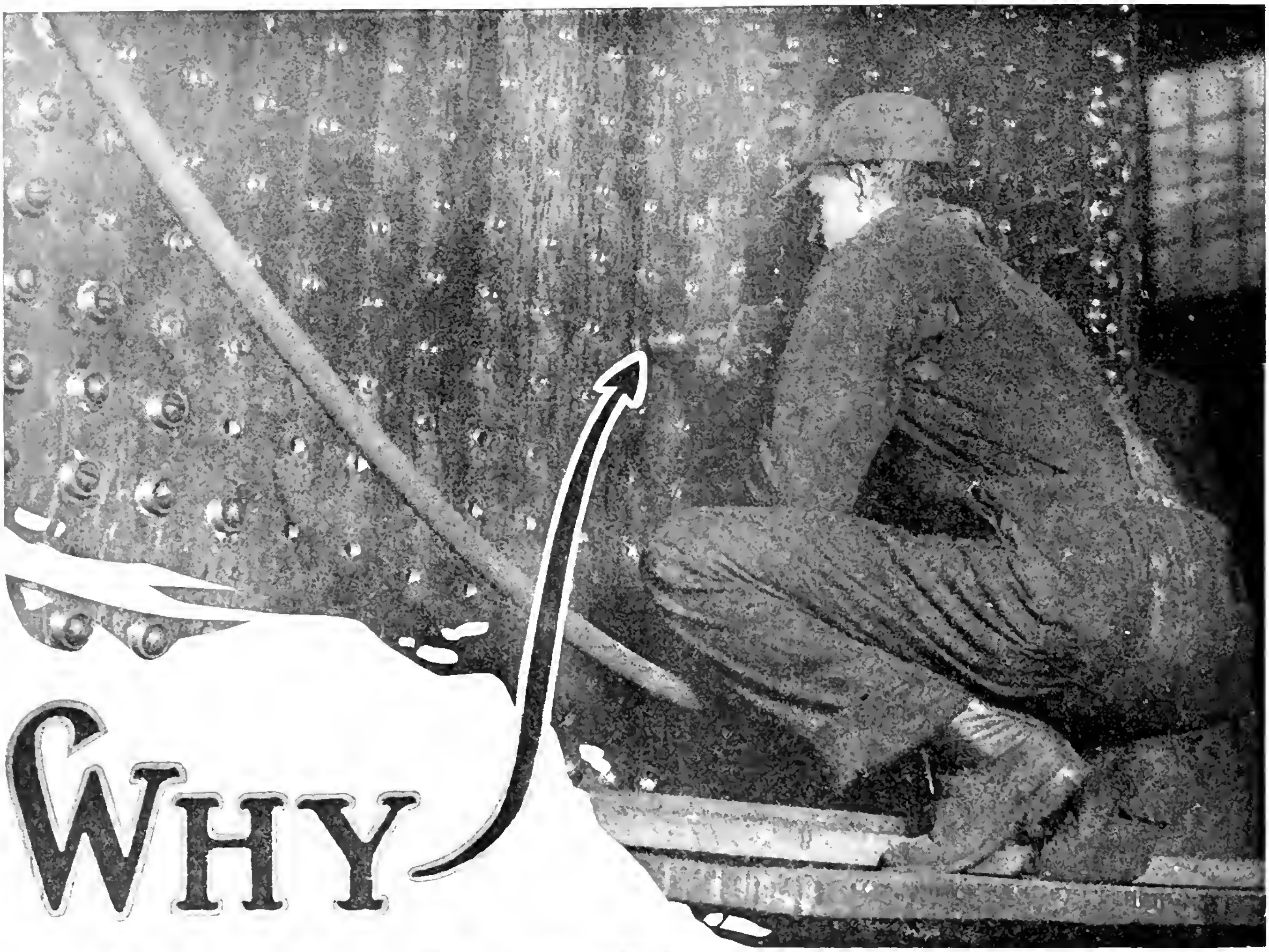


THE BOILER MAKER

DECEMBER, 1923

High Pressure Tank Used for Testing Aircraft

By Cyrus Hankins

The story of the construction of the aeronautical testing chamber given below indicates the adaptability of the shipyard machinery to the fabrication of heavy plate structures that could not be accommodated in the ordinary tank shop. The shell plates in this tank are 2⅛ inches thick, the heads are made of 1¼-inch plate and the heaviest single plate weighs 15,820 pounds. The general outline of the preliminary layout and final assembly of the tank bring out a number of special methods used by the Newport News Shipbuilding and Dry Dock Company that might well be adopted on other types of heavy tank construction.

A FEW months ago work was completed by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., on a special form of wind tunnel or aircraft testing tank, detailed information for which has only recently been released for publication. This tank is used to house a wind tunnel and is capable of withstanding an internal pressure of 300 pounds per square inch.

The only information on the requirements of the tank given to the builders by the National Advisory Committee on Aeronautics were the general dimensions and the details involved in the arrangement of the wind tunnel.

The general dimensions of the tank are as follows:

Outside diameter of tank	15 feet 0 inch
Length cylindrical shell	20 feet 6 inches
Length overall	34 feet 6 inches
Working pressure per square inch	300 pounds
Test pressure per square inch	450 pounds
Thickness of shell plates	2⅛ inches
Thickness of hemispherical heads	1¼ inches

There is an access door in one head, 3 feet by 3 feet 6 inches clear opening, with a sight hole at the center of the door, or on the center line of the cylinder. The opposite end has provisions for a stuffing box and bearing for a propeller operated on the inside of the chamber by a shaft extending through the head of the chamber. Electrical connections and other attachments are provided as necessary.

Materials of Construction

The material used for the shell, and the plate portion of the heads was oil hardened steel, 60,000 pounds minimum

Fig. 1.—Completed Tank Ready for Shipment

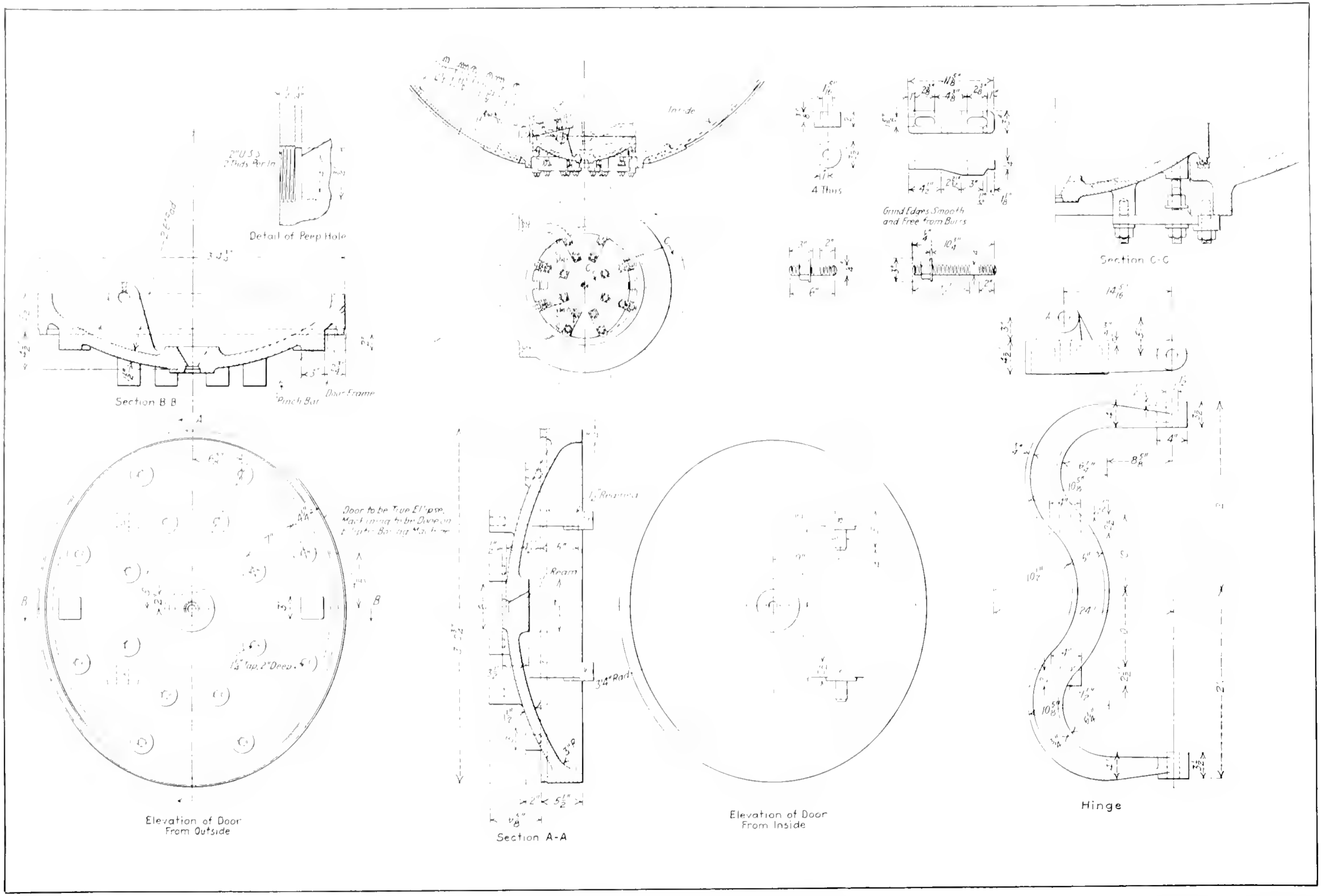


Fig. 2.—Details of Doors and Frame Castings

tensile strength, of boiler flange quality. The heaviest single plate weighed 15,820 pounds. The rivets were made from oil hardened steel, 55,000 to 65,000 pounds tensile strength, the manufacturers furnishing certificates covering the tests.

The steel castings were made by the builders from electric furnace steel, and were of quality equivalent to United States Navy grade "B," having 60,000 pounds minimum tensile strength, with other requirements as for grade "B" castings. Test coupons were taken from all castings and subjected to all required tests.

The Cylindrical Shell

It was decided to make the cylindrical shell in three courses so that the heads might be identical in so far as their fit to the shell was involved. Also the bending power of the available plate rolls was a consideration. The length of courses and the location of the circumferential seams is such that the rivet pitch in the longitudinal seams, for each course, may be the same and of the proper pitch for the necessary efficiency.

The thickness of shell for the cylindrical portion was determined in the usual manner and found to be 2⅛ inches. The rivets in the longitudinal seams are 1¾ inches diameter with 1 13/16-inch diameter holes with a pitch in the outer row of 10 3/16 inches. A triple riveted seam, rather than one with a greater number of rivets, was found desirable, as the plate efficiency could not be improved except by a greater pitch in the outer row, and a pitch of 10 3/16 inches was considered the limit for satisfactory calking of the butt straps. The large rivets of such length presented an unusual problem so experiments were conducted in driving 1¾-inch diameter rivets in a combined plate thickness of 5⅛ inches which was the greatest combined thickness of shell. These plates were then cut through the rivets and it was found that they filled a 1 13/16-inch diameter hole almost perfectly in every case. Hydraulic riveting was used. The butts are of equal thickness and width inside and outside.

The circumferential seams are triple riveted lap joints. The load per inch of length along the circumferential joint being only one-half that for the longitudinal joint for the same diameter, this type of joint was satisfactory. Rivets 1⅝-inch diameter with 1 11/16-inch diameter holes were used, it being desirable to use as small rivets as possible. The pitch of rivets in the rows is slightly less than three diameters which is the usual pitch. The total number of rivets in each row, however, was worked out to be a number divisible by four as well as six which was a laying out and assembly requirement, it being always essential to have a rivet fall on the vertical as well as the horizontal center lines and in this case the heads being made in six pieces it was also essential that the rivets in each head sector be alike, which is the necessity of being divisible by six. The stresses in the rivets and in the plate between rivets in the circumferential seam are less than those in the longitudinal seam, but are proportional.

The rolling of the plates was exactly the same as for a large Scotch boiler except for their unusual thickness. The drilling was done with a three stand special boiler shell drill. The machining of the plate edges was done on the usual type of plate planer. After drilling all plates were taken apart and rivet holes cleaned free of burrs.

The butt straps for the longitudinal seams were bent cold to the required radius between curved dies under a 200-ton hydraulic press.

The rivets for the cylindrical shell were hydraulically driven. All seams and rivets were calked in the usual manner.

Design of the Hemispherical Heads

The design of the heads presented a very interesting problem. Bumped heads were found impractical, because it was impossible to secure plates of sufficient size to make them from one piece, and the different radii encountered in a bumped head would make joints in it very difficult. Cast steel heads were considered but the weight involved, and the difficulties of attaining good castings for heads of one piece, and the unsatisfactory joint that could be developed with a multiple piece head, caused this to be abandoned. A hemispherical head made of six pieces was finally adopted. The principal reasons for this shape were, that the unit load along an element of a hemisphere is only one-half that along a longitudinal element of a cylinder of the same diameter. This would result theoretically in a plate thickness of only one-half that of the cylindrical shell, provided as efficient a joint could be developed. Also this hemispherical head of at least six sectors was a shape that could be generated under dies more perfectly than any other shape.

In ordering the plates for these head sectors, an approximate development was made based on the length of great

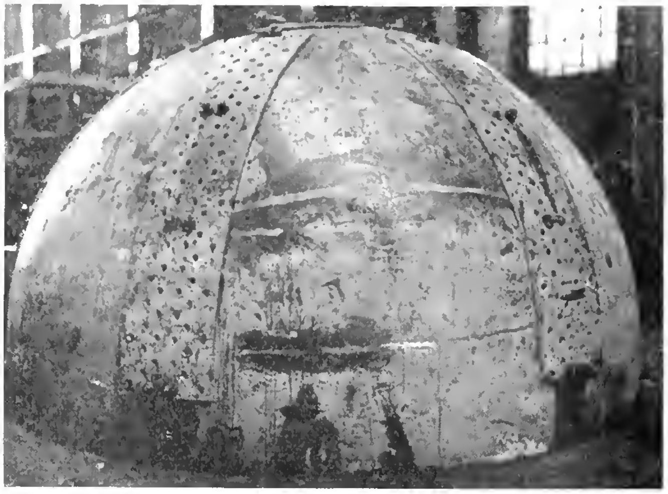


Fig. 3.—Head in Process of Assembly

circle arcs, taken at a series of equidistant positions and an allowance of about 2½ inches was made on every edge. The sketch to which the plates were ordered was made in straight lines, however, no attempt being made to trim plates in ordering or before bumping to their final shape. Two small scale plates, about ⅖ scale for all dimensions, were bumped between dies of the same scale and a study made of the behavior of these plates in being shaped. One sample was bumped from the flat, and the other rolled longitudinally to the desired radius and then worked between the dies. Great circles were then layed off on these small plates and the lengths of the arcs measured to determine the behavior of the plate, it was found that there was practically no stretching in any part of the material, the greatest longitudinal length being only about ¼ inch greater than before bumping. But there was shown to be a decided contraction in the width as measured on great circle arcs. This contraction was such in these ⅖ scale models, that should it be proportional in the full size plate it would take at least half of the 2½-inch allowance given in ordering. This proved true in bumping the full size plates.

The thickness of the head plates was made 1¾ inches, which was 3/16 inch in excess of the theoretical thickness, to have the same stress as in the shell with an equally efficient seam. This excess was given to cover unknown factors that might result from furnace work and local heating. The inner and outer butt straps, as well as the circular butt strap adjacent to the head end castings, were formed to spherical surfaces of the proper radius for their respective positions. A liberal excess was allowed in the ordered width of the butt

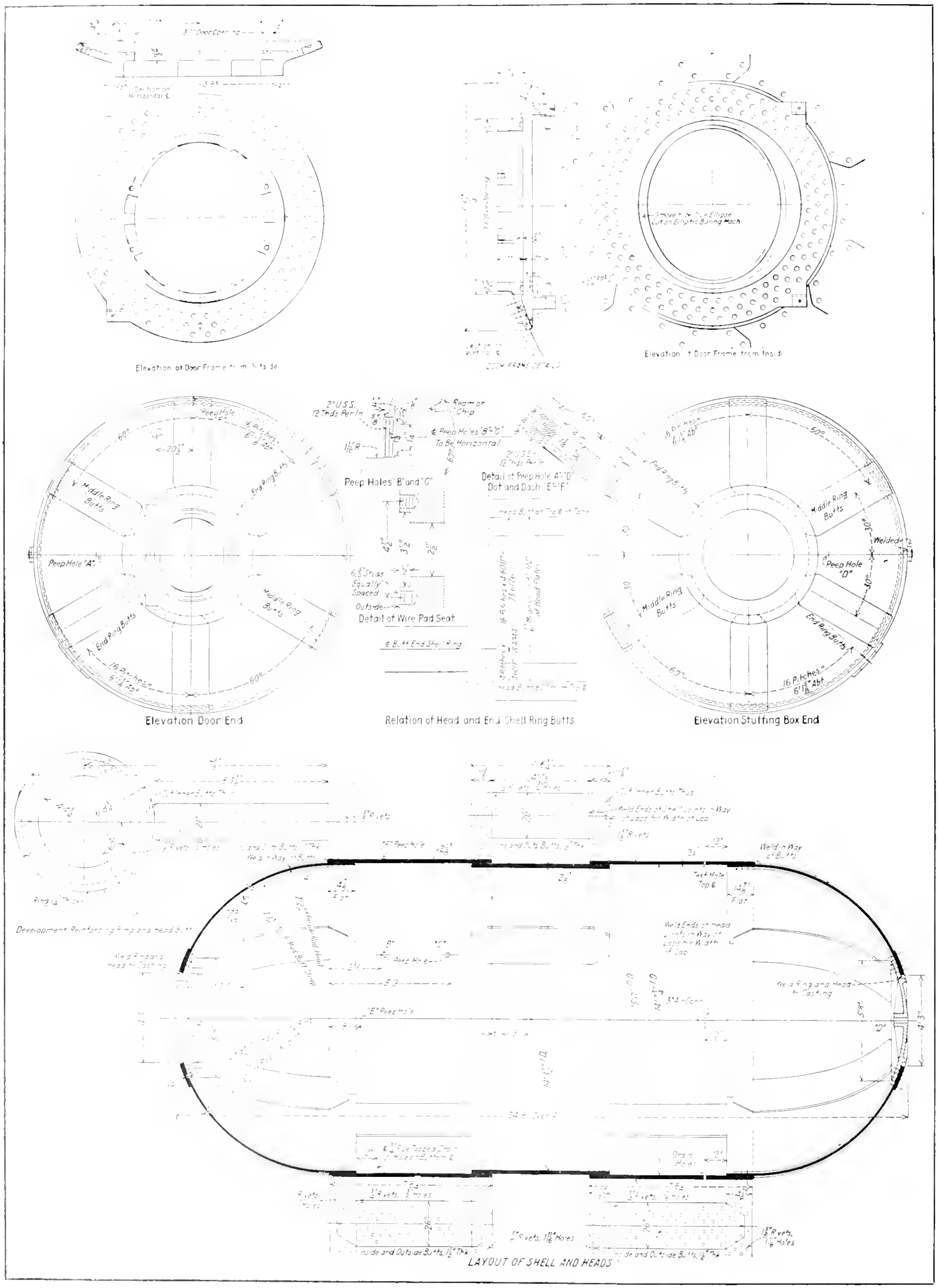


Fig. 4.—Layout of Shell and Heads for Testing Chamber

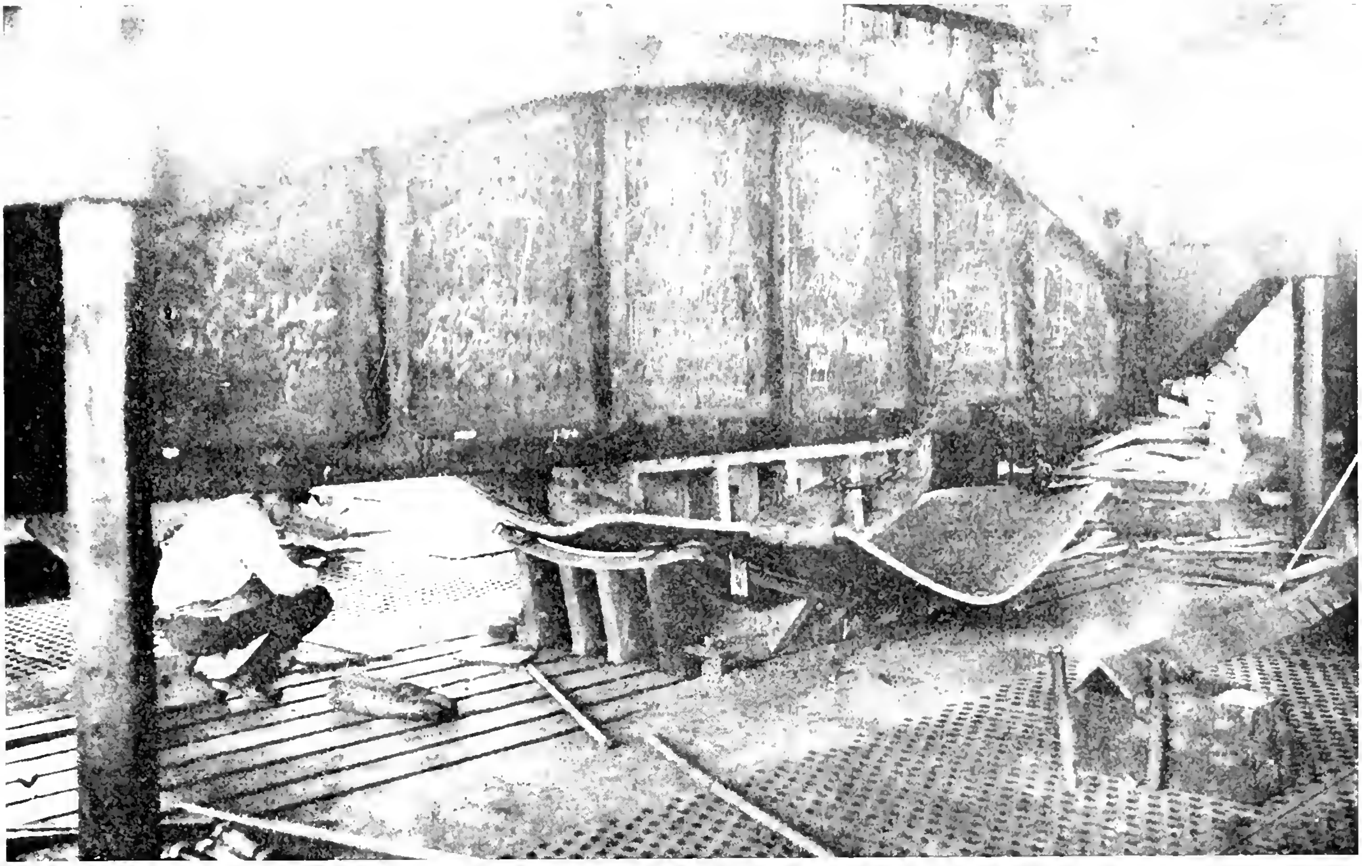


Fig. 5.—Bumping One Section of the Air Chamber Head

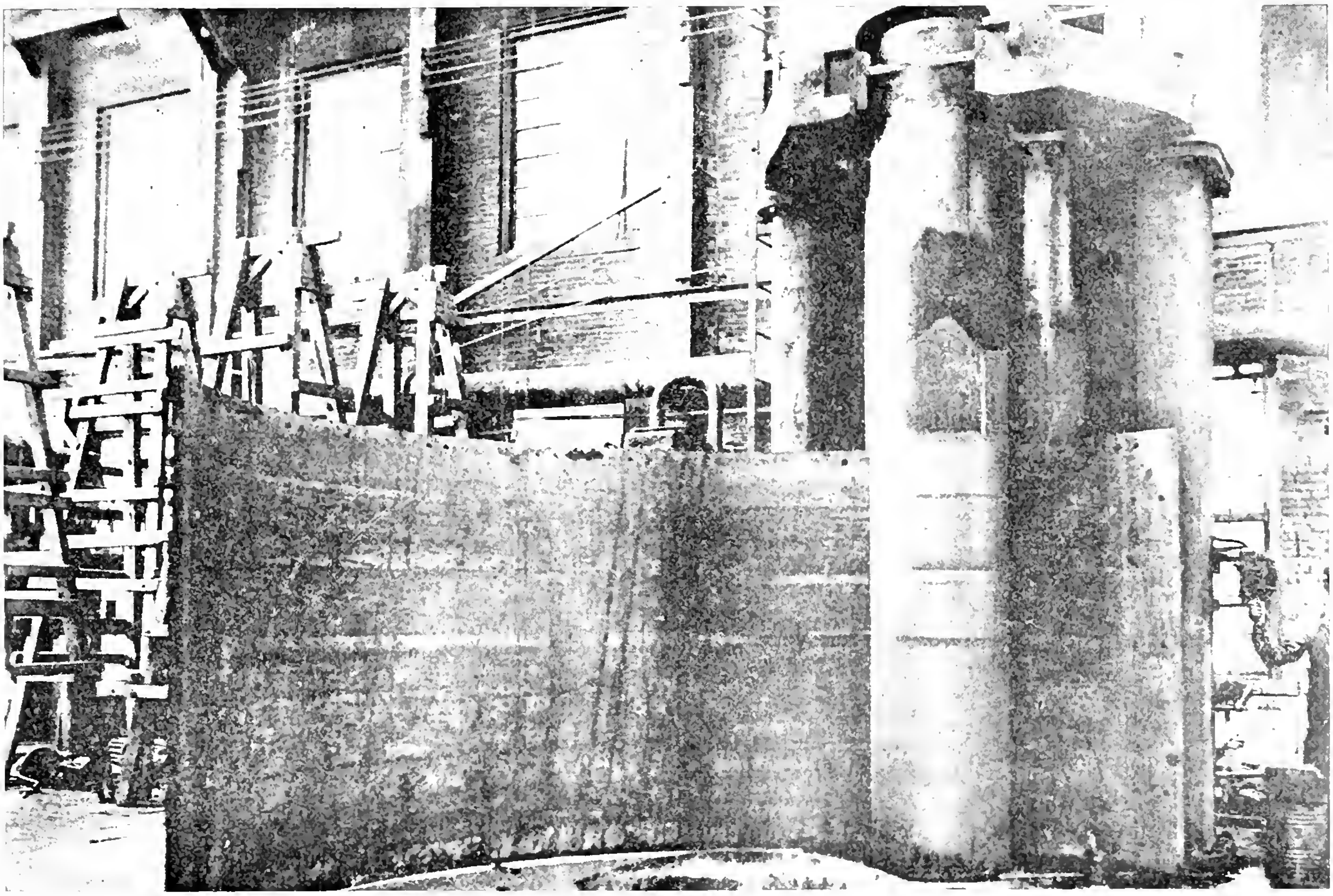


Fig. 6.—Heavy Vertical Rolls in Action Rolling the Shell

straps to provide for a possible wind in their length in being formed, which excess was found desirable on some plates, while others remained practically straight along their edges.

For generating these spherical head sectors and butt straps, upper and lower dies with spherical surfaces corresponding to the inside and outside radii of the head plates were used. The lower die was about 7 feet by 7 feet, being made like a basin with its inner surface corresponding to the outer surface of the head. The upper die was about 7 feet long by 2 feet wide and had its outer surface corresponding to the inner radius of the head. These dies were fitted in a 600 ton hydraulic press.

The plate was brought to a light red heat in a nearby furnace, then handled by crane to the edge of the lower die. The narrow end of the plate being inserted between the dies first, the plate was passed by successive steps of about 2 feet between the dies. After forming the entire plate at one heat, as was done, the plate was worked between the dies in numerous small, or smoothing out, impressions. This operation tended to remove any distortions that the already spherically formed portion of the plate may have suffered. On fully cooling it was found that there had been a very slight shrinkage, with reductions in all directions, including the radius. This change in the desired radius was corrected, being at maximum only about 3/8 inch in a 7-foot 25/8-inch radius, by putting the plates through the dies cold and subjecting them to numerous impressions of the upper die.

The forming of the butt straps and the circular butt at the end of head was identical with the forming of the head plates. The dies were shimmed to suit the varying radii, made necessary by the difference in the inner and outer butt straps.

The laying out of the head sectors for assembling, was accomplished by the use of a wooden templet made to the inner radius of the head and for 1/6 of the head. This templet included the 14 7/8-inch portion that was to form the lap of the head with the cylindrical shell. This portion being formed spherically along with the rest of the head sector for sake of ease of manipulation between dies, and was pulled back to a cylinder after assembly of heads. This templet was laid in each formed plate and scribed around.

Six head sectors after chipping were set up to form a complete head, any high spots resulting from chipping were marked, and the sectors match marked, then taken down and all high spots chipped so that the head assembled with exactly the desired circumference.

The heads were fitted on the ends with castings in general already described. The door frame casting was designed with the addition of the 1 1/4-inch circular butt to compensate for the cut away portion of the hemispherical head plate.

The door opening, in the door frame casting, as well as the door were made elliptical to allow the door to be inserted or withdrawn at any time.

The machining of the packing groove and contacting face of door are to a perfect ellipse, being generated on an elliptic boring mill. All other machining on these castings was done in the usual manner.

The packing used in the packing groove is Johns-Manville, Kearsarge, Style No. 176 1/2, made continuous to special order to suit the groove. The load on this packing at 300 pounds per square inch working pressure is approximately 3,400 pounds per inch of length.

The door was designed for relatively low stresses, to Bach's theory for stresses in structures supported at their periphery and uniformly loaded and checked by methods used for figuring stresses in steam turbine diaphragms and other similar structures. The door is provided with eight dogs, capable of exerting a pressure on the gasket equal to about one-half that exerted by the working pressure, which was considered ample to compress the gasket sufficiently to overcome leakage at low pressures. The door weighs approximately 1,500 pounds.

The door hinge owes its peculiar shape to the necessity of being able to move the door inwardly with practically parallel movement until it has reached a point at which the dogs are clear of the door frame. Also the hinge is bent backward at the center to clear the line of vision from the peep hole at the center of the door.

The castings were all made as simple and rugged as possible to facilitate foundry work, machining, assembly, and with the view to keeping down secondary stresses as far as possible.

The assembly of the heads to the shell differed little from a large Scotch boiler, the door, hinge, and other castings offered no difficulty, being machined to fit.

The test was by hydraulic pressure of one and one-half times the maximum working pressure, or 450 pounds per square inch.

Welding was extensively used to secure all seams and butt strap ends, not readily accessible for calking.

Opportunity for American Manufacturers to Exhibit Products in Europe

THE fair held at Lyons, France, each year is by far the most important annual exposition in Europe. The next meeting of this fair in Lyons will be from March 3 to 17, 1924.

An opportunity is available through the official delegate of the Lyons fair for the United States for American manufacturers, especially those who specialize in labor-saving devices and machinery to exhibit at the coming exposition. Those manufacturers who cannot spare the time and expense of attending the meeting personally can join the all-American demonstration and trade exhibit now being organized here.

The Lyons Fair is the most important commercial and industrial manifestation today on the continent of Europe. This fact will be better understood when it is stated that, at the 1923 meeting of the Lyons Fair, local records have shown the number of actual buyers to be over 160,000, while the total number of visitors exceeded 400,000.

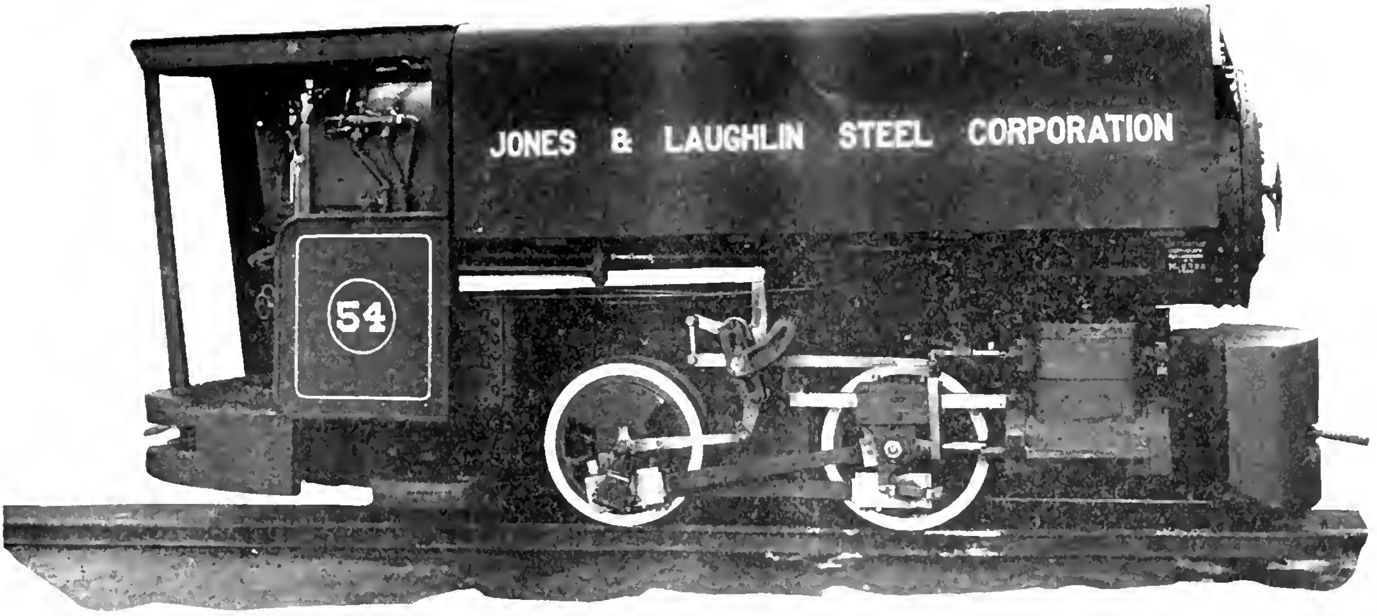
The Lyons Fair is not a mere show intended to attract crowds of visitors. It is first and foremost a sample Fair, that is a business Fair in the fullest meaning of the word. The main purpose of this institution is to develop trade, to facilitate transactions, to bring the producer or manufacturer and their products to prospective buyers. Everything else has been made subservient to this purpose. The booths provided constitute real business offices where business men can get together and discuss their transactions with the utmost comfort and privacy with as much ease as they would in their home office or factory.

The Palace of the Lyons Fair, which will be completed in the near future, will be one of the most prominent attractions of Europe, where it is already considered a marvel of architecture, convenience and size. It will extend over three-quarters of a mile. Twenty pavilions will be ready in the spring of 1924, the whole constituting a unique business city such as can be found today in no other country.

M. Herriot, the mayor of Lyons, came recently to the United States for the purpose of calling the Lyons Fair and its business opportunities to the attention of American manufacturers and to invite them to come in great numbers to the next meeting of the Fair (March 3 to 17, 1924).

Similar visits made by M. Herriot in the last few years to England, Switzerland and even Russia proved highly successful and have made the Lyons Fair one of the greatest international events in the world of business.

For full information in regard to the Lyons Fair, apply to Emile Garden, Official Delegate for the United States and Canada, 50 Church Street, New York.



Compact, Heavy Locomotive for Steel Mill Service

Small Heavy Locomotives Built for Mill Service

Extra Heavy Plate Used in Boiler and Throughout Structure to Bring Locomotives to Required Weight

By C. E. Lester

SOME rather unique locomotives recently built for the Jones and Laughlin Steel Corporation are illustrated in the accompanying drawing and photograph and briefly described in the following paragraphs; the features of the design lying principally in the great weight carried on a short wheel base and narrow gage track.

There were many limiting factors entering into the design that, in a measure, prohibited the following out of generally accepted principles of locomotive construction and caused a departure from such principles, or rather some modifications of ratios, etc.

Due to mill conditions for clearance, the overall height was limited to 7 feet 3 inches and the width to 4 feet 10 inches over a gage of 23 inches. The curvature of the track required a wheel base of not over 48 inches and with heavy duty and an extremely slippery rail weight of about 60,000 pounds was desired for adhesion. The extreme length over bumpers is 17 feet, yet the load on the track is distributed over the very small area of 1,104 square inches or about 54 pounds per square inch of track area. These locomotives are operated over a railroad constructed of 120 pound rails and steel cross ties.

Extreme Weight for Size of Locomotive

This weight on a locomotive of this size where the weight would normally be about 40,000 pounds, required the addition of weight wherever possible, without interference with the working parts. The needed excess weight was added in many places, having in view the necessity of correct distribution and the desire for symmetrical lines. For example, the saddle tank weighs about 6,500 pounds, the boiler front is of double thickness, as is also the smoke stack; the steam chests and cylinders are massively built; the frames are of slab construction 3 inches thick with practically no cut outs except for the journal boxes and as required for the cylinders, firebox, etc.

Walschaert valve gear has been used, which places the moving parts where they can be easily oiled and cared for, while at the same time these parts are fully protected from accident by heavy castings at front and rear. Stephenson link motion had previously been used on this class of locomotives, but with such a narrow gage and large driving boxes as well as crowded conditions, the Walschaert gear is decidedly to be preferred.

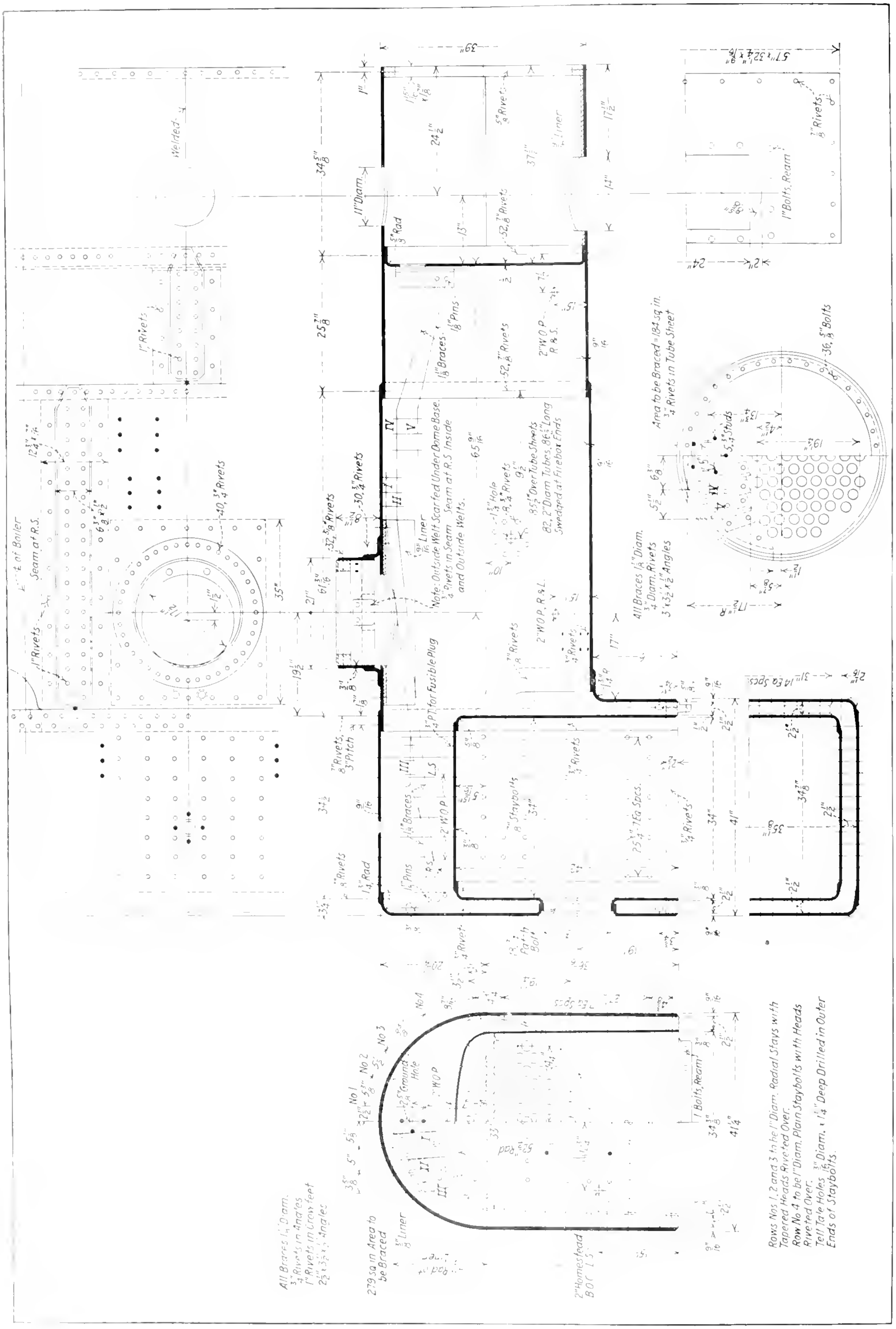
It will be observed that the front and rear cast steel bumpers are of great weight and hang closely to the rail. These perform their normal functions as well as provide weight and act as buffers for foreign obstructions along the tracks.

The steel castings bolted to either side of the frames under the firebox have dual functions. They act as buffers to prevent possible injury to the valve gear and rods, while the engines are in reverse motion; provide weight and at the same time bring the center of gravity to a point where the weight is equally distributed over both driving wheels.

Type of Boiler Used

Of the boiler but little may be said of the specific construction only that for purpose of weight, the plate and rivets were increased in size. For boilers of this size and pressure ordinarily $\frac{3}{8}$-inch plate and $\frac{3}{4}$-inch rivets are used. In this case $\frac{9}{16}$-inch plate was used in the shell and wagon top with 1-inch rivets in the horizontal seams. Incidentally the construction of the shell would permit of a working pressure of 280 pounds at a factor of safety of 5. However, the working pressure is set at 180 pounds, as the firebox is of normal construction and the additional metal in the shell was added for weight only.

The company's usual practice was followed out in using



General Details of Small Locomotive Boiler the Porter injector check flange. This flange permits the setting of the water supply opening in the boiler either above or below the center line of the boiler, with the opening in the flange at right angles to the center line and with a full allowance of thread. One size flange may be used on boilers of various diameters.

In order to secure a maximum number of full threads in the washout holes at the mudring corners, the holes are drilled 1/2 inch small and rolled out with a special roller which thickens the plate at least 25 percent at the edge of the hole.

The boilers were built to the A. S. M. E. locomotive code, and have all mudring corners autogenously welded. The cylinders are 11 inches by 14 inches, and driving wheels are 25 inches in diameter.

No wood whatsoever was used anywhere on the locomotives, the cab and fixtures all being of metal. Due to the necessity for conservation of space the cab is small, all fixtures and moving parts closely placed and the area for the engineer somewhat confined.

Due to heat radiation from the boiler and the operation of the locomotives in close proximity to hot ingots and hot ingot molds the temperature of the water carried in the saddle tank varies in temperature from 100 degrees F. to 140 degrees F., a preheater, so to speak.

Coal is used for fuel, it is carried in an ingot car attached to the back end of the locomotive.

Conserving the Eyesight of Industrial Workers

"EYE Hazards in Industrial Occupations," widely known as Publication No. 12 of the National Committee for the Prevention of Blindness, first issued in 1917,, has been revised, greatly enlarged, widened in its scope, brought up to date and will be ready for distribution about January first, Lewis H. Carris, Managing Director of the Committee, announces.

The bulletin, which has been out of print since 1921, will combine in its revised form all the available information on the subject of eye hazards in industrial occupations. The field research work on the revised edition, which has been carried out under the direction of Mr. Carris, will contain the most comprehensive statistics on eye accidents available. Cooperating with the Committee in the revision of the bulletin were: the National Safety Council, the Safety Institute of America, the American Society of Safety Engineers and leading ophthalmologists.

The volume will be distributed to heads of departments of industrial plants, to engineering colleges and technical schools, and all others interested in accident prevention and health promotion among industrial workers.

There will be twelve chapters in the revised bulletin dividing the contents as follows:

Chapter I, the Introduction, will give a brief résumé of eye hazards in industry and of the safety movement, especially as it relates to the prevention of eye accidents, will discuss the proper point of view toward these hazards, emphasizing the need of physical examination of employees and pointing out that elimination of eye hazards is not only a moral obligation but good business. It will also state the place of the National Committee for the Prevention of Blindness in the general movement for the conservation of the vision of industrial workers.

Chapter II—The Nature and Causes of Eye Injuries—discusses where and how eye accidents happen, and gives detailed data regarding eye injuries in various industries.

Chapter III, devoted to the Eliminating Eye Hazards by Engineering Revision, emphasizes the importance of this newest phase of accident prevention work and describes several typical instances of engineering revision which eliminated hazards and improved the process.

Chapter IV, entitled Industrial Accidents and Safeguards, will take up in detail, hazards and protective methods, all processes where protection is required from large flying objects, from small flying particles, from dust and wind, from splashing metal, from gases, fumes and liquids, from reflected light or glare, from injurious radiant energy, etc.

Chapter V is devoted to First Aid Treatment for Eye Injuries.

Chapter VI, entitled Correction of Defective Vision, will discuss the condition of eyesight found in the physical examinations of large numbers of working men and women and a description of the experiences of large employers such as the United States Steel Corporation.

Chapter VII will enumerate the various industrial diseases affecting the eyes and will present the most effective methods of protection against these diseases.

Chapter VIII, devoted to Eye Diseases emanating outside of industry, will discuss, among other diseases, trachoma and the responsibility of industry to help eliminate it, means of its detection, and preventatives.

Chapter IX describes Industrial Lighting, including lighting codes, artificial lighting, natural lighting and glare.

Chapter X, devoted to the Safety Movement, discusses the contribution to the movement for the elimination of the eye hazards of industry which have been made by the National Safety Council, the Safety Institute of America, American Society of Safety Engineers, Underwriters' Laboratories, local organizations devoted to safety, and the various state industrial commissions.

Chapter XI, headed Education as to Safety, is subdivided into the education of the employer, of the employe and of the State. It cites statistics to show that it is cheaper to prevent accidents than to pay for them, takes up the pros and the cons of gogglewearing, outlines a complete eye protection campaign, presents the best known means of inducing so-called hard-boiled workmen to wear goggles and discusses the moral and economic obligation of the state in safety education.

Chapter XII is devoted to the National Committee for the Prevention of Blindness and its work during the past ten years.

Exhaust Steam Injectors

FOR several years past the exhaust steam injector has been used successfully in this country for locomotive boiler feeding, but in the United States such appliances have not until recently been given much attention. At the present time the International Railway Fuel Association is investigating the subject, and the conclusion has been arrived at that, although there is not quite so great a range with the exhaust steam injector as one using live steam, the range is sufficiently great to meet the requirements of average service under American locomotive conditions. It is pointed out that locomotives and trains on British railways, which use the exhaust steam injector extensively, are not so heavy as those in the States, but since the performance of the device is considered quite satisfactory, it seems reasonable to expect successful results under the heavier conditions of service. Tests already carried out in America with the form of injector mentioned have shown coal savings from 10 to about 15 percent, the best results, as a matter of course, being obtained when the exhaust injector was kept continually at work from one end of the line to the other. Some of the most advanced and efficient locomotives on British railways are fitted with exhaust steam injectors, and we are accustomed to hear the device spoken of by those responsible for the working of the engines in terms of appreciation.—*The Railway Gazette* (London, England).

Government Inspectors Report—

Two Locomotive Boiler Explosions Caused by Blown Flue Pockets and Low Water Crown Sheet Failure

By A. G. Pack*

A great degree of interest has been shown by our readers in the locomotive accident reports which from time to time appear in the pages of THE BOILER MAKER through the courtesy of the Bureau of Locomotive Inspection. For this reason we are outlining below two disasters both fatal which once more bring home to those men having to do with boiler maintenance and repair that the lives of many fellow human beings depend on the conscientious manner in which they do their work.

CHICAGO, Rock Island & Pacific Railway locomotive 2132 was dispatched from Shawnee, Okla., at 6 A. M. on July 3, 1923, in freight service, and when at a point about 2 miles west of Harrah, Okla., or 20 miles from Shawnee, and while running at an estimated speed of 20 miles per hour, a flue pocket blew out of the front flue sheet, when the escaping steam and water from the boiler caused the flames and firebox gases to be blown back into the cab, resulting in the serious injury of the engineer and the fireman who was with him.

This locomotive was turned out of the Shawnee shops of this carrier on July 1, or two days prior to the accident, after having received class 3 repairs and was at the time of the accident making its first regular trip in freight service since receiving repairs. During the repairs all flues were renewed and 40 flue pockets, which had been previously applied, were renewed and 8 additional flue pockets were applied, making a total of 48 flue pockets applied in the front flue sheet for the purpose of closing holes from which flues had been removed when changes in the firebox sheet were made.

Examination of Flue Pocket

Examination disclosed that neither the flue pocket which blew out, as illustrated in Fig. 1, nor any of the others, had been prossered, but were only held in place by friction.

The flue pockets were applied by a boilermaker helper and were inspected by the company boiler inspector, who signed and swore to the annual locomotive inspection and repair report, dated July 1, 1923, showing that all flues were in good condition. The report was approved by the general foreman, as officer in charge.

Our examination of locomotives Nos. 2120, 2135, 2139 and 2144 disclosed that in each of the front flue sheets there were 48 flue pockets which had not been prossered, or means provided to secure them in place, other than friction. The carrier's records show that all of these locomotives received new flues and flue pockets during the period January to April, 1923.

Fig. 1 shows the flue pocket as applied and held only by friction, while Fig. 2 shows the manner in which the flue pocket should have been prossered or enlarged inside of the flue sheet, which would have prevented it from blowing out.

The necessity for properly prossering or enlarging flue pockets inside the sheet is so well recognized by mechanics that comment hardly seems necessary. The workmen who did this work and the supervising officials in charge who permitted it cannot be too strongly censured for such careless and indifferent methods, which show an extreme disregard for safety on their part.

The Bureau of Locomotive Inspection has seriously objected since its inauguration to flue pockets being applied in the firebox flue sheet because of unsafe conditions created. It has not, however, objected to flue pockets applied in reasonable number in the front flue sheet when properly belled and prossered, but we do not approve as being proper and safe practice of applying the number of flue pockets which were found in this instance, for the reason that it leaves a large unsupported area and throws an undue strain on the remaining adjacent flues.

Crown Sheet Failure

On August 19, 1923, the boiler of New York, New Haven & Hartford locomotive 409 exploded, resulting in the fatal injury of the engineer and serious injury to the fireman and two passengers.

This locomotive left Providence, R. I., at 3:00 P. M., August 19, hauling passenger train No. 3344, consisting of two coaches and a combination car. The train had proceeded to a point about one-half mile from Walpole Heights, or a distance of about twenty-five miles from Providence, when at 3:59 P. M. the boiler exploded, resulting in the fatal injury of the engineer, who died 10 days later, and the serious injury of the fireman and two passengers. The engineer and the fireman were thrown by the force of the explosion from the locomotive and were found in the river alongside the track.

Locomotive 409 was a 2-6-0, or ten-wheel type, equipped with extended wagon top boiler having a narrow radial stayed firebox. The force of the explosion tore the boiler from the frame and running gear, hurling it a distance of approximately 300 feet, where it struck the ground and rebounded, and came to rest about 350 feet ahead from the point of explosion.

Firebox Construction

The firebox was originally of five-piece construction, consisting of flue sheet 1/2 inch thick, and 2 side sheets, crown and door sheets 3/8 inch thick. The crown sheet was supported by 16 longitudinal rows and 28 transverse rows of stays, of which the 6 center rows were of the button-head type, excepting the first 2 transverse rows back of the flue sheet and the first transverse row in front of the door sheet were hammered heads. The crown stays were 1 1/4 inches in diameter at the threaded ends, with bodies reduced to 1 inch diameter, spaced 3 3/4 by 3 3/4 inches. The staybolts varied in diameter from 1 inch to 1 1/8 inches, and were spaced 3 3/4 by 3 3/4 inches.

The firebox had been patched as follows, with seams autogenously welded, which showed that the metal had not properly fused:

*Chief Inspector, Bureau of Locomotive Inspection.

One patch between the eleventh and twelfth rows of stays each side of the center line of the crown sheet, extending from the eighth to the seventeenth staybolt, counting from the flue sheet.

Two patches, one on each side, running full length of the firebox between the fourteenth and fifteenth longitudinal rows of staybolts, counting from the center line of the crown sheet.

Door sheet had been welded to side sheets for a distance of 44 inches up from mud ring.

Welded seam across the entire width of door sheet 21½ inches below top of crown sheet.

The top portion of the door sheet was riveted to the crown sheet, while the flue sheet was welded to both the crown and side sheets.

Examination of Firebox After Accident

Investigation disclosed that the crown sheet had been overheated, due to low water from the flue sheet to the door sheet, extending between the seventh and eighth rows of stays on each side of center at the front and between fourth and fifth rows on each side at the back end. Many of the crown stay holes were elongated, in some instances as much as 1 inch, and the crown sheet stretched to a thickness of approximately ⅛ inch in places where it tore.

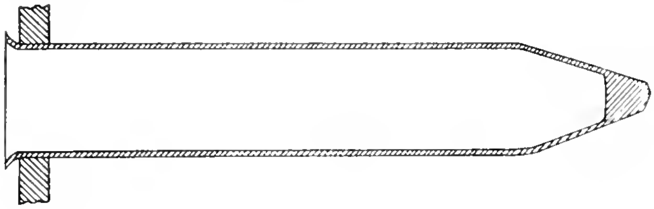


Fig. 1.—Flue Pocket Without Being Prossered as Applied to Locomotive 2132 and Others

The crown sheet pulled away from 298 stays and ruptured; the initial rupture apparently beginning at the welded flue sheet seam near the center line of the crown sheet and followed this seam, which was very defective, down to the welded seam on the right side sheet, which seam failed for a distance of 26¼ inches through the weld, then through the solid plate for a distance of 11½ inches, then through the welded seam for a distance of 33 inches, then through solid plate for a distance of 13 inches, and again through the welded seam for a distance of 13½ inches, or to the door sheet. The fifth sling stay on the right side in the first transverse row was missing and showed an old break at the wrapper sheet. The ninth and tenth stays adjacent on the right side in the first transverse row, thirteenth stay from the flue sheet in the sixth row, and the twenty-seventh stay in the ninth row were broken with old breaks, making a total of 5 broken crown stays and 1 broken sling stay.

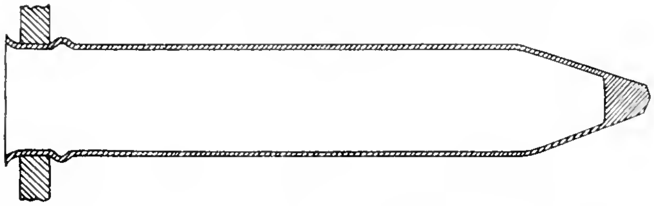


Fig. 2.—Flue Pocket Properly Applied by Being Rolled, Belled and Prossered

Considering that the ninth and tenth adjacent stays were broken, and the defective condition of the welded seam, and the manner in which the sheets tore, it is evident that the initial rupture occurred in this seam and that the violence of the explosion was increased by the failure of the welded seam.

Water Glass. The boiler was equipped with an Ashcroft prismatic water glass, the bottom stem of which was bent and the top stem broken off at the frame—free from scale and sediment.

Gage Cocks. The boiler was equipped with three gage cocks, screwed in the back head, near the knuckle, which were broken off at the time of the accident, one of which was not found. The two which were found were free from scale and sediment.

The left injector, right check valve, and steam gage were badly damaged and their condition prior to the accident could not be determined. The right injector, left check valve, safety valves, tank and tank wells were in good condition. Right tank hose was in good condition except that strainer was missing, and the left tank hose was missing.

Daily Locomotive Inspection Reports

Daily locomotive inspection reports were examined covering the period August 1 to August 18, the date prior to the accident, and the following conditions found reported at Southampton Enginehouse, Boston, Mass.

August 1, 1923, 8:40 A. M.—Side sheet leaking right side, staybolts leaking around thread. Not serious enough to dump engine.

August 10, 1923, 8:30 A. M.—Leaking around firebox door. Side sheet leaking right side. Engine dumped. Staybolts hammered, leak in fire door calked.

August 11, 1923, 8:30 A. M.—Side sheet leaking right side, leaking around firebox door. Staybolts leaking around thread. Not serious enough to dump engine.

August 11, 1923, 1:10 P. M.—Side sheets and staybolts leaking in firebox. Staybolt leaking around thread, not serious enough to dump engine.

August 14, 1923, 8:45 A. M.—Side sheets leaking both sides. Leaking around firebox door bad. Engine dumped. Staybolts headed over and hammered. Leak around firebox door calked.

August 15, 1923, 8:45 A. M.—Leaking around firebox door bad. Side sheet leaking left side. Boiler check sticking right side. Firebox not leaking bad enough to dump engine.

August 16, 1923, 8:45 A. M.—Leaking bad around firebox door. Side sheet leaking left side. Boiler check sticking right side. Engine dumped. Leak around firebox door calked. Staybolts hammered.

August 17, 1923, 8:35 A. M.—Side sheet leaking right side. Engine not dumped. Staybolts leaking around thread. Not serious enough to dump engine.

August 18, 1923, 9:15 A. M.—Leaking around firebox door. Engine not dumped. Leak calked.

Classified Repairs

This locomotive received class 3 repairs at the Readville shops during the month of May, 1922, at which time the following boiler work is shown to have been done:

One-half door sheet renewed and welded on top and both sides.

Seams on both side sheets patched, right 5 inches by 44 inches and left 5 inches by 48 inches. Patches welded on bottom and ends.

Both sides of back head patched, right 5½ by 29 inches and left 5½ by 25 inches.

Cracked welding on both corners on back flue sheet repaired by electric welding.

Notwithstanding the defective condition of the firebox, as indicated by the repairs made and the defective conditions evidenced by the daily locomotive inspection reports from August 1 to 18, inclusive, we have on file a sworn annual locomotive inspection and repair report, dated at

(*Continued on page 355*)

Saving Boiler Tubes by Treating the Feedwater*

Experience of Several Roads with Various Methods of Softening Water in Hard Water Districts

The Kansas City Southern, traversing a territory from the Missouri river to the Gulf of Mexico, has experienced a water condition, encountered on only a few other roads, which has been the cause of excessive boiler maintenance costs on the first district and the terminal division where all engines are furnished water from the Missouri river. This water contains from eight to 30 grains of incrusting solids to the gallon, depending on the stage of the river.

During the low water stage of the river when the water was very hard most damage was done to boilers, due to corrosion and pitting and frequent failures from leaking and bursted flues, required renewals of these parts.

In November, 1921, water treating plants were put into operation at both terminals and five intermediate water stations on the first district and the handling of all plants turned over to the mechanical engineer, who assigned a chemist to look after the proper handling of each station, analyzing each water and prescribing the proper amount of chemicals necessary. Owing to the frequent changing of the water in streams where water is obtained, it is the practice to make analysis of the water, both before and after treatment, at least once a week, and change the amount of chemicals to meet the requirements.

The pumper or water tender was instructed as to the proper methods of handling each plant, such instructions being strictly complied with and the water situation successfully handled for a period of 10 months when failures began to develop from foaming. Each failure reported was investigated and in each case found to be the result of improper treatment of the water at one or more plants or because the boiler had not been washed. Numerous cases of foaming during this period from September 1, 1922, to April 1, 1923, caused by soap, red cup grease, lye, washing powder and other foam producing substances put into water cisterns of locomotives during the shopmen's strike, were charged in some cases to the water treatment.

During the low water stage of the Missouri river the first part of this year when the total hardness was as high as 30 grains to the gallon, it was necessary to use excessive quantities of chemicals to reduce this hardness to four or five grains. This made the water so light that foaming ensued on engines engaged in heavy service. During such periods anti-foam compound in quantities of one pint to each 4,000 gallons of water is used, which eliminates the foaming difficulties and permits of efficient and economical locomotive operation.

Decrease in Flue Leakage

During the shopmen's strike beginning July 1, 1922, we experienced very little boiler or flue leakage on locomotives operating with the above treated water and very good results and improved engine performance was made possible on the second district where locomotives only received approximately 20 percent treated water.

Flues removed from locomotive boilers operating on the treated water district are not altogether free from scale, as the locomotive was either in service before the advent of feed water treatment or was sometimes run for several trips at a time over other territory where treated water is not available.

The old practice of blowing out large quantities of water at each water station has been discontinued, and instead the blow-off cocks are operated for a few seconds at frequent intervals, thus releasing the accumulated sludge adjacent to blow-off cocks.

In the Red river country of Arkansas, Louisiana and Texas the water contains such quantities of hardness that heavy formation of scale and pitting prevails. Compound is being used to avoid scale formation with very satisfactory results. When excessive quantities of anti-scale compound are used, sometimes foaming results, and to avoid foaming each locomotive is furnished a supply of anti-foaming compound for use only in case of foaming.

Trouble from Foaming

In a salt water territory where water contains from 45 to 65 grains of salt, trouble is experienced from foaming on an evaporation of 4,000 gallons of water with boiler of approximately 3,200 gallons capacity. The foaming tendency develops on a salt concentration of 100 grains and the locomotive becomes almost inoperative on a concentration of 175 grains. This difficulty is readily overcome by the use of anti-foam compound. The boiler is blown out well every four hours, water changed on four days' performance and washed after each seven days' run. The water consumption averages 870 gallons per hour, the boiler blow-out releasing about 400 gallons on each 4,400 gallons' performance, water changed on 28,000 gallons and boiler washed on an evaporation performance of 48,000 to 50,000 gallons. Under this method of handling, locomotives are operated successfully. The evaporation between wash-outs could be increased by the greater use of blow-off cocks, but the additional cost due to waste of fuel would more than offset the cost of wash-outs and fuel for firing up.

Boiler Washing Period Lengthened

In has been the past practice to wash boilers on a calendar-day instead of on evaporation performance, which is not satisfactory in pooled engine service, as locomotives often work from 12 to 20 hours per day in times of heavy traffic movements. In one locality boiler foaming was found, presumably on account of using a certain boiler compound, but upon investigation it was found that the engines were being run far beyond the limit possible on account of the high concentration. The past practice was to wash the boilers every seven days. These engines, however, worked from 12 to 20 hours a day in pooled service instead of eight hours a day on former regular assignment, therefore the evaporation between wash-out had been increased from 50,000 (where the concentration was great enough to justify wash-outs) to over 110,000 gallons, when excessive foaming developed, making economical and efficient locomotive operation an impossibility.

This difficulty has been overcome by adopting a boiler wash-out board to be handled by the engine dispatcher or enginehouse clerk who marks up the board every trip the engine makes, and when it has made the desired number of hours or miles the boiler is washed out.

On the Chicago division of the Pere Marquette, between Grand Rapids, Mich., and Chicago, and also on the subdivision between Holland, Mich., and Pentwater, boiler chemicals are in use, while on the territory between Toledo, Ohio, and Saginaw, Mich., another compound is being tested.

Water Softening Compounds

One of these compounds is made up in one-pound sticks, and is applied by placing from 8 to 16 pounds (according to

*Report read at thirty-first annual convention of Traveling Engineers' Association, Chicago, September 11 to 14.

size of boiler) into the several different wash-out holes in the boiler after the boiler has been washed. This compound, among other ingredients, contains treated mercury, which attacks the scale that has already formed on the bolts, tubes and sheets, breaking it loose. The scale does not all drop off, but is loosened and will turn on the bolts and braces similar to a bushing. Most of it is dislodged and washed out at the following wash-out period. Great care is necessary in washing the boilers that are heavy with scale before applying this treatment, as large quantities of scale will be dislodged and accumulated. This will inevitably result in mud burned sheets.

The other compound is made up in one-pound round balls and is applied by placing the required number of balls in a container, which is attached to the intake pipe of the wayside tank. An analysis of the water is taken in order to determine the amount of compound that is necessary to neutralize the water at any particular tank. The chemical acts by attacking and precipitating the scale-forming solids in the water before it reaches the locomotive tank, thereby prohibiting, to a large extent, the formation of scale. It is handled by the maintenance of way men, a specified number of balls of compound being placed in the container every 24 hours, according to the analysis of the water.

Practically no trouble is experienced with engines foaming or boilers pitting. The problem is to keep boiler tubes, bolts and sheets from being insulated with scale. The scale is of the carbon magnesia type, and before using any water treatment it was not uncommon to find the tubes, bolts and sheets insulated with scale 3/8 inch to 1/2 inch in thickness. In some instances scale formation exceeded these dimensions. While the boiler compound has not entirely eliminated the formation of scale, it has greatly reduced the thickness of scale insulation. It is a rare instance to find over 1/16 inch to 3/32 inch scale on engines running in territories where boiler compound is in use. Where formerly it was necessary to reduce nozzles as scale formation increased, a standard size nozzle is now maintained. Engines that were formerly run with 6-inch nozzles are now running with 6 1/4-inch nozzles. This has not only reduced the fuel consumption of our locomotives, but has increased their efficiency, due to the decreased back pressure.

There are nine less hot workers employed at Saginaw and Wyoming than formerly; this alone has resulted in a saving of approximately $50 per day or a total of $18,250 per year. At the power plant at Saginaw shops there is a battery of four 250-horsepower Wickes type boilers. It formerly took two men 18 hours to thoroughly wash and turbine each of these boilers, which were washed once every 30 days. This is now being handled by the same number of men in an eight-hour period, and the wash-out has been extended from 30 to 60 days, resulting in an annual saving of $658.56. The period between wash-outs has not been increased on locomotives, the practice being to wash engines every 10 days.

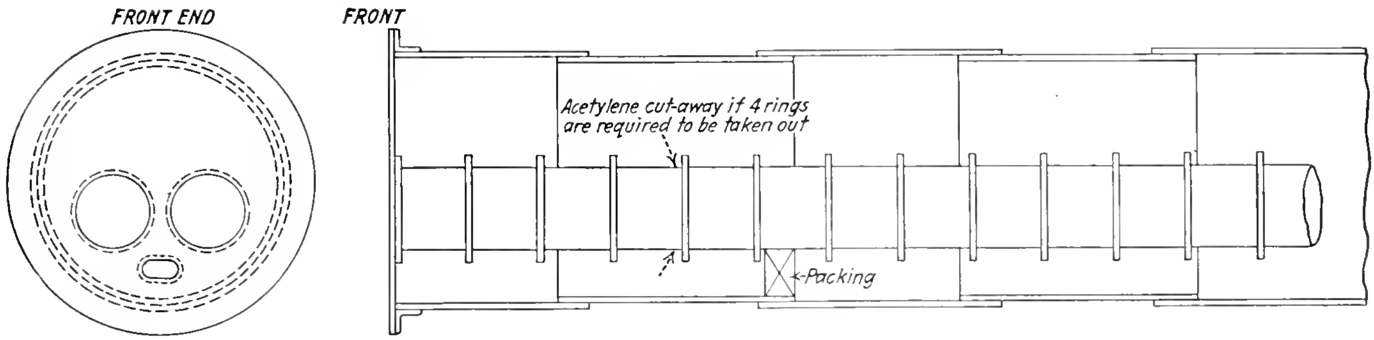
The report was signed by T. H. Clapham (K. C. S.), chairman; G. M. Basford (Lima Locomotive Works, Inc.), C. F. Willoughly (P. M.), J. H. Alter (N. Y. C. & St. L.) and J. H. Cooper (Dearborn Chemical Co.).

Renewing Flue Rings in Lancashire Boilers

British Practice of Withdrawing Tubes, Cutting Away Defective Flue Ring and Assembling New Ring

By H. Holmes

It is the universal practice in England when renewal of one, two, three or four defective firebox flue rings is necessary, to take off the front end plate of the boiler, also to take the rivets out of the flues adjoining the back end plates so as to release the flues for drawing out of the shell of the boiler to enable the cutting away of the defective flue rings.



New Method of Arranging Firebox Flue Rings for Ready Removal

Various methods and practices for drawing out flues are adopted. In some instances, a runway is made in the boiler bottom or rollers are installed, or the flues are placed on a special carriage and with the aid of a crab and rope blocks the flues are drawn sufficiently out of the boiler to enable the cutting away of the defective rings, also the assembling and riveting of the new rings to the existing flues.

The following is a method which proved very satisfactory in the renewal of several flue units each of four defective firebox flue rings of a high pressure Lancashire boiler which may be of interest to many readers of The Boilermaker.

The flues were securely jacked up with timbers at about the center of the boiler; all the rivets were taken out of the front end plate and the plate lifted clear of the boiler. The true lengths of the required new flue rings were next obtained.

Oxy-Acetylene Cutting Torch Used

The oxy-acetylene cutting torch was brought into operation, this machine cutting the fourth ring of each flue, around the plate near the flange. With the aid of a pair of pulley blocks connected to the top center gusset stay the four defective furnace rings of each flue were lifted out of the boiler.

When the new four firebox flue rings arrived from the makers riveted and calked on three rings ready for assembling, one was lifted into the boiler with the aid of pulley blocks and bolted closely to the existing flue, which was then riveted.

The second four rings were treated in a similar manner to the first. When the riveting was completed the front end was bolted in position, the rivet holes electrically drilled around the flue ends. Following the riveting and calking the flues were joined to the front end plate. The joint of the new firebox portion with the existing flue rings was calked only in the internal flues.

When completed the boiler was tested to 240 pounds per square inch hydraulic pressure with no sign of leakage at the flue ring joints. The boiler has been in constant service for nine months working at a pressure of 160 pounds per square inch and giving every satisfaction.

Advantages Derived by the Above Method

When the defective flue rings are burned off by the oxy-acetylene cutter the full diameter of the shell is available for the cutting off and the punching out of the rivets of the existing flue rings, thus requiring no turning and lifting of the flues or scaffolding, etc., as in the case when the flues are drawn out of the boiler. No blockage in the firehole when cutting away the defective plates and assembling and riveting the new rings to the existing flue rings is necessary. No crab and wood patching are required.

The chief advantages are at the back end of the boiler, a large percentage of high pressure Lancashire boilers having superheaters attached, entail added cost in taking the superheaters out and replacing them, the necessary brick work that must be removed to enable the taking out of about 126 ⅞-inch rivets and replacing them and calking around the flue ends all add to the cost of other methods.

The only difficulty in the new method is the riveting of seven rivets down the shell side of the boiler of each connection of the flue rings. The difficulty was easily overcome by one man being on top of the flues and working downwards and one man working upwards from the underside of the flue. When riveting the flue rings, cotter bolts were installed down each side of the shell for bolting up the boiler while assembling the flue plates.

The time taken for the renewal of flue rings by the new method was considerably less than when using the old method.

Proposed Standards for Steel Flanges for High Pressure

A COMPREHENSIVE program of standardization of steel flanges and flanged fittings was launched at an open meeting of sub-committee No. 3 held in the rooms of the American Society of Mechanical Engineers, Friday, October 26. This sub-committee is a sub-division of the sectional committee on the Standardization of Pipe Flanges and Fittings which was organized under the procedure of the American Engineering Standards Committee. The three sponsors for this project are: committee of Manufacturers on Standardization of Fittings and Valves, the Heating and Piping Contractors National Association and The American Society of Mechanical Engineers.

The informal conference on this subject which the sponsors held on May 23 indicated such widespread interest in this subject that it was decided to organize a new sub-committee to develop standards for flanges to withstand high superheat temperatures and pressures from 250 to 3,200 pounds per square inch. Professor Collins P. Bliss of the Mechanical Engineering Department of New York University who is chairman of the sectional committee has decided to act also as chairman of this sub-committee. The other members of the Sub-Committee No. 3 are J. C. Bannister, C. W. E. Clarke, Sabin Crocker, R. D. Hall, H. E. Haller, J. A. Hance, C. H. Haupt, H. C. Heaton, J. S. Hess, F. Hodgkinson, D. S. Jacobus, O. F. Junggren, M. B. MacNeille, V. T. Malcolm, W. S. Morrison, W. A. Pope, G. W. Saathoff, J. R. Tanner and H. L. R. Whitney. H. L. R. Whitney of the M. W. Kellogg Company was elected secretary. This list includes official representatives of the American Society for Testing Materials, Hydraulic Society, Power Piping Society, National Electric Light Association, the A.S.M.E. Boiler Code Committee, and the sponsor bodies. A few of the members of this sub-committee were appointed "at large" because of their special interest in and knowledge of this subject.

The open meeting held on October 26 which was also this sub-committee's organization meeting was attended by 50 engineers, manufacturers of this product and users as well. The session lasted all day and the following important actions were taken:

Range of Pressures for Steel Flanges. The maximum steam pressures for which these standard flanges and flange fittings shall be developed are 250, 400, 600, 900, 1,350, 2,000, 3,200 pounds per square inch. The maximum temperature which they are to be designed to withstand was set at 750 degrees F.

Two Hundred and Fifty and 400 Pounds Steam Standards. These two steel standards are to have the same bolt circle and number of bolts as the present American cast-iron standard for 250 pounds, except that the 2 and 2½-inch sizes for the 400 pounds standard will have eight bolts instead of four. The other dimensions of these flanges are, however, to be modified to meet the conditions set for each.

Six Hundred Pounds Steam Standard. The sub-committee further decided to use as the basis of the dimensions of this standard the bolt circle and the number of bolts of the present 800 pounds Hydraulic Standard developed by the A.S.M.E.

Nine Hundred Pounds Steam Standard. The basis for this new steam standard flange is to be the bolt circle and the number of bolts of the present 1,200 pounds Hydraulic Standard developed by the A.S.M.E. committee.

Standards for 1,350, 2,000 and 3,200 Pounds Steam Pressures. Flanges to withstand these pressures and the corresponding superheats are to be developed after the completion of the first four of the series. It will be noted that the seven maximum pressures selected form a geometrical series between the terms 250 and 3,200.

Sub-Committees Elected

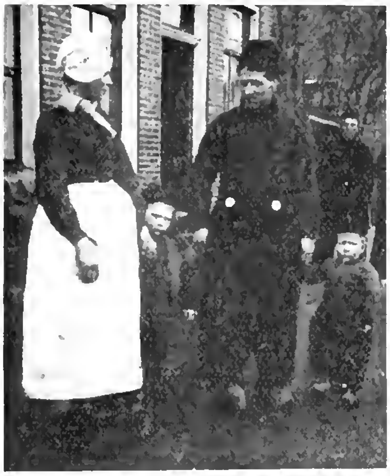
Realizing the difficulty and inefficiency of 20 men trying to complete the details of these flange standards, Sub-Committee No. 3 elected two sub-committees. One of these headed by A. M. Houser as chairman and Mr. H. L. R. Whitney as secretary, is to select from among the American Society for Testing Materials specifications the one best suited for this purpose and to set the limiting stresses and such tests as are considered to be necessary.

The second subdivision of "No. 3" is to be known as the "Working Committee." It has C. W. E. Clarke as its chairman and Mr. Whitney as secretary. When the working committee receives the report of the sub-committee on the physical and chemical properties it will begin its work on the dimensional standardization. It will then carry on its work intensively since it is required to present its report to the members of the full Sub-Committee No. 3 in writing at least a week prior to the second meeting which was held at the time of the A.S.M.E. Annual Meeting.

Inspecting Boilers in Holland—

The Dutch Inspector Finds His Chief Employment at Pumping Stations and in the Seaport Towns

By George Cecil



THE activities of the Dutch boiler inspector are almost limitless, for, when the day's work is over, he continues to take life seriously. Ever keen on acquiring knowledge, Frans turns his attention to mechanical engineering and to kindred subjects, "burning the midnight oil" till a late hour in the pursuit of knowledge. He also superintends the education of his children, since the girls are expected to know something more than the "three R's," while the boys are destined to become, in their turn, boiler inspectors—or, perhaps, full-fledged engineers. So when the children have prepared their task for the next day's class, *Mynheer* puts them through their paces. And woe betide the little Hans, or Gretchen, who fails to afford satisfaction—no snuggling between the sheets till the lesson is learned.—Education bulks large in Holland and the boiler inspector has no intention of wasting school fees on idle scholars. He means to have his money's worth—to the last *florin*.

Sometimes the indefatigable Frans, being dissatisfied with his monthly pay and traveling allowances as a government boiler inspector and with the retiring pension which awaits him after a certain number of years' service, flies at high game. The position and salary of a mill engineer appeal to him, and, to that end, he studies engines and machinery, besides familiarizing himself with the working of each mill which he visits when on his frequent tours of inspection. Every now and then an ambitious man has this desire gratified:—capability and interest combined land him in the hoped-for billet. If, however, the boiler inspector is doomed to remain in his original calling, he does not repine. Frans argues (wise man) that had fortune smiled upon him the job would not have been permanent and that he might, a few years later, have found himself without employment—and, worse still, minus a pension. So, with a degree of philosophy which is not even equaled in the East, the boiler inspector resigns himself to the inevitable, and works none the worse for being disappointed. Decidedly the right spirit.

Other men, though not wanting in ambition, have no intention of deserting "the substance for the shadow." Buoyed up by the pension looming in the future, they are content to rise, in grade succession, to the post of head inspector, a position which carries with it a substantial salary and a fair amount of leisure. "There is," says the Dutch proverb, "a pot of gold at the end of the longest road."

The "Trekschuyt and the Hoogaar"

At one time all the pumping stations, being steam-operated, had Frans' attention; now, like many another installation, a percentage are driven by electric power. As, however, at least half of the 565 stations (employed to regulate the water level and to prevent flooding in the reclaimed country) are worked by steam, the boiler inspector cannot say that the bread has been taken from his mouth. The largest of the electric pumping stations, by the way, is at Zoutcamp, near old-world Groningen and has five pumps. The installation, with the exception of those in America, is the largest of its kind in the world.

The twelve important sugar refineries, as well as a number of lesser ones, paper mills, shipbuilding yards, sea-going and river-going steamers, railways and textile mills, also keep Frans busy. Incidentally, traveling to his destination may be a lengthy business, for, the Netherlands being a country of waterways, the journey often is made by canal in a *trekschuyt* (horse-towed barge). Or a *hoogaar* (sailing barge) takes the place of the *trekschuyt* when the destination entails crossing an inland sea to some distant island estuary. But time is not of great importance in Holland; only upon the distance being completed is punctuality expected. Having arrived, the boiler inspector presents himself with clockwork punctuality at the mill or works. More is not expected of him.

German Inspectors Invade Holland

Of late a number of German boiler inspectors have found their way into the lowlands—and rather to the indignation of their Dutch *confrères*. The last-named argue that Holland is intended for the Hollanders, and that Germans should earn their living in Germany. Steps, in fact, have been taken to memorialize the Government, especially by the younger members of the corps of boiler inspectors, who declare that to admit the alien is utterly wrong and unfair. The older men, like Brer Rabbit, "lie low and say nothing"; they are too near a well-earned pension to interest themselves in the matter. Besides, Germany and Holland are such good (political) friends that there may be something behind the invasion.

On the eastern frontier, the inhabitants of which are almost as much German as Dutch, little objection is raised to the intruders. When, however, they make their appearance at western Rotterdam and Amsterdam, where steamer boilers, not to mention those of the dock elevators and floating cranes, require attention, the Hollanders are up in arms. Nor does the invaders' lusty singing of "Deutschland über Alles!" help matters!

A Born Economist

The Netherlands boiler inspector has several excellent characteristics. Ever anxious, for example, to acquire a knowledge of geography, he takes his annual holiday abroad. The well laid-out boulevards of Paris, together with its attractive Bois, have Frans' attention, while he also makes the acquaintance of Vienna and Budapest. A trip is made to Brussels and to Antwerp, and—funds permitting—even to far-distant Naples. He samples London, for which his respect is great; the German itinerary includes Berlin and other important towns; and the Alps are climbed. Upon returning home, the boiler inspector comes to the conclusion that Holland is hard to beat, for he is a true patriot.

These excursions are, of course, expensive. But Frans is a born economist; he has elevated the art of living on very little money and saving *florins* in every possible direction to a science. And when on his travels the boiler inspector with a thirst for information does not spend a cent more than is necessary, while he subsists—if driven to it—chiefly on soup, bread and cheese. Sight-seeing is considered more important than the call of the stomach. Besides, the traveler is used to a diet in which inexpensive (and nutritious) cheese plays an important part: 'tis the staple food of the Netherlands and he thrives on it. When, however, Frans again finds himself in his native land something more interesting than cheese awaits him. The neighbors, anxious to learn what he thinks of a foreign country, ply him with many a filling dinner, *schnapps* and *advocäat* (a cordial in which gin, rum, yolk of egg and sugar are cunningly mixed) being thrown in. The wanderer makes up for his enforced abstinence.

"Does the boiler inspector," you may ask, "take his wife with him?" Most certainly not, for he considers that the suitable place for the *Vrow* is the home circle. Though a fond husband and father, Frans is a practical economist.

Black Sheep

If the Dutchman of pure blood is a model of all the virtues, the half-breed on the Belgian frontier is the reverse. The admixture of blood, as invariably is the case, has resulted in bad qualities, and the Belgian-Dutch steam machinery users occasionally get themselves into trouble with the authorities. The boiler inspector condemns a boiler as fit for the scrap-heap, to find, on his return visit, that it still is in use—though liable to burst at a moment's notice. When Frans peremptorily orders a thorough overhauling and the substitution of new seamless steel tubes for the old ones, the proprietor of the plant makes promises which he has no intention of keeping! Riveting is jibed at, because it costs money; nothing short of fine and imprisonment will induce the half-caste to replace a damaged gage cock or a worn firebox. Little wonder that the law-abiding Hollanders have a healthy contempt for these people. Elsewhere in Holland such occurrences are well nigh impossible.

The Belgians, for some curious reason, greatly resent the attitude of the Dutch to the boiler users of mixed race, passionately asserting that their misdeeds are exaggerated. The Hollanders retaliate by stating that every half-caste ought to be cleared out of Holland. A drastic measure.

Activity in Retirement

The retired boiler inspector sometimes finds employment in a boiler making concern as shop foreman or in some other capacity. If, however, Frans pines for an existence in which activity is blended with peacefulness, he takes to flower, fruit and vegetable gardening. The national tulip has the veteran's attention, his choice blooms carrying off a prize at the local horticultural show, while the produce of the kitchen garden keeps the table well supplied. The Dutchman is a gardener at heart; consequently, the ex-boiler inspector experiences no difficulty in making a success of horticulture. He may become the envy of the professional grower.

These healthy pursuits are carried out in some picturesque little townlet, where the pensioner inhabits a gabled house of modest dimensions. Or a roomy cottage, the walls of which are distempered yellow, purple, rose, or cream, according to the district, accommodating him. A streamlet, which is crossed by a tiny bridge, separates the property from the road, and the cottage is surrounded by its garden, the chief ornament of which is a lily-laden pond. Here Frans contentedly passes the evening of his days growing prize vegetable-marrows, giant pumpkins, luscious pears and apples of surpassing flavor, and cultivating wonderfully variegated tulips. He asks for nothing better.

In his boiler-inspecting days Frans has eschewed the Dutch costume, which consists of astonishingly shapeless pantaloons, a double-breasted jacket terminating at the waist and buttoning up to the neck, a high peakless cap, and—when pottering about in the mud—glogs. In his retirement he sometimes reverts to this unpretentious garb, the wearing qualities of which are marvellous. Well does it become him.

Vocational Training Now Open to Adult Workers in Various Industries

ADULT wage earners who wish to receive technical training which will help them in their occupations may now secure such training from the public school, announces the Federal Board for Vocational Education.

Under the Federal and State Vocational Education Acts, funds are available to assist the public schools in each community to set up adult evening classes for wage earners. To receive such instruction, it is necessary that a group of workers, employed in a common industry, take the initiative by organizing themselves into a class. Next, they should present themselves to the local school authorities and request an instructor. The local school board is empowered to provide an instructor and a class room to the applicants. Thereupon, the class begins its sessions on a regular nightly schedule.

In some cases, no instructor, qualified to teach the desired subject, is available. In such cases, the local school authorities may call upon the state supervisor of trade and industrial education. The state supervisor details an instructor to the community. If no technically qualified instructor is available in the state, the supervisor takes steps to train an instructor especially for the needs of the class. In some cases one of the members of the class is given this training to instruct the others. In no case is a group of workers denied assistance until all possible methods of aid have been exhausted.

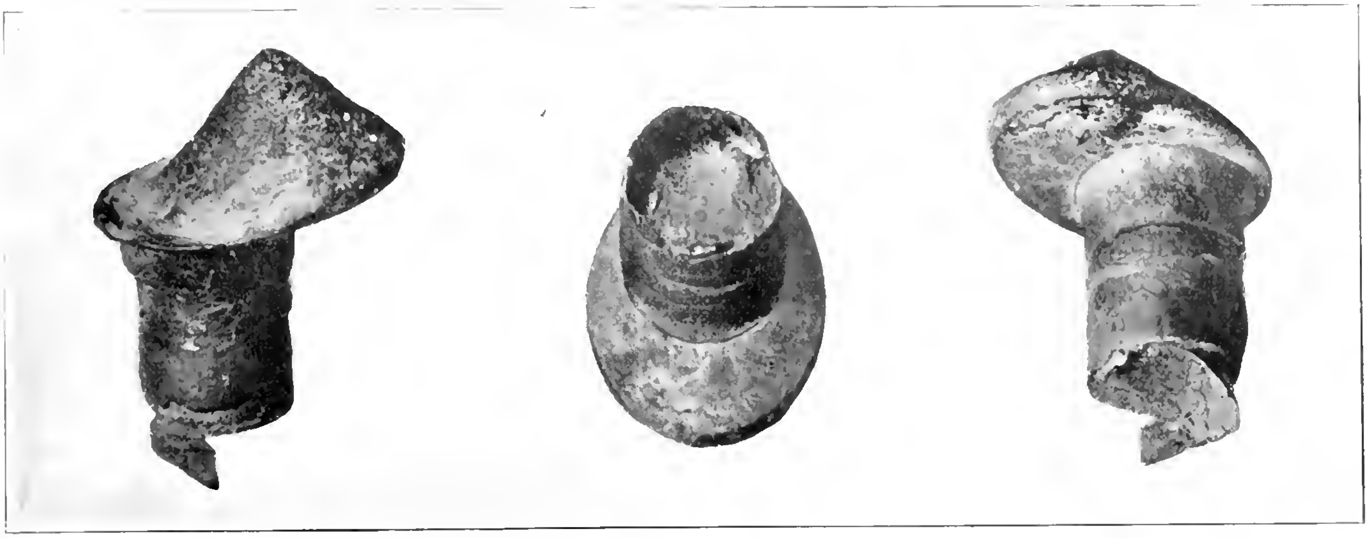
The only restriction that the public schools lay upon such adult extension work is that all members of the class be workers, actually employed in the trades for which they desire training. Thus the mistake of training workers for trades in which they can not get employment is avoided.

Successful results have been obtained through such classes in many communities, the board declares. A notable example has been the work among the coal miners in southern Illinois. Last year over 1,000 miners were enrolled in evening extension classes, studying to qualify for executive positions. The state supervisor reports that, of the many miners who took examinations for higher positions after completing the night school course last year, all passed, giving a 100 percent record to the schools.

Workers in many other communities would duplicate the record of the Illinois miners were they aware that the opportunity of public school instruction is open to them, it is believed. Hitherto, it has been the impression of the general public that public school vocational education was restricted to boys and girls. However, adult education has a high place on the program of the Federal and State Boards of Vocational Education. It is only necessary that the workers themselves take the initiative in asking for it, the Federal Board declares.

INSPECTION BUREAU FINDS DEFECTIVE 55 PERCENT OF LOCOMOTIVES EXAMINED.—The Interstate Commerce Commission's monthly report to the President on condition of railroad equipment shows that during October 6,507 locomotives were inspected by the Bureau of Locomotive Inspection and 55 percent were found defective, while 525 were ordered out of service.

Some Evidence of the Need for Inspection*



Three Views of a Seriously Defective Rivet

THE illustrations presented herewith show a rivet that was recently removed from a steam boiler that had been in active service for no less than eighteen years. It was one of a row of 28 rivets that were similarly defective and it illustrates the kind of work that is too often done in boiler shops where there is no proper supervision. A job of this kind should never be allowed to leave the shop, and any riveter who is willing to turn out such work should either be disciplined in some effective way, or be summarily discharged. The hazards that are unavoidably associated with steam boilers are serious enough and it is unpardonable to increase them, wantonly, by riveting up the joints in so careless a way. It is true that the boiler had held together for a considerable time, but its factor of safety was certainly a good deal smaller than the designer intended, and there is no way of knowing how much longer it could have withstood its load, if it had not come under inspection, which promptly detected the poor workmanship and led to immediate remedial measures, to make the boiler safe.

Defects in Forming Rivet

This specimen illustrates most of the things that can be wrong with a rivet. The most conspicuous feature about it is, that the head is very eccentric, being offset to such an extent that the vertex (or tip) of it comes in direct line with the cylindrical surface of the shank, instead of opposite the center, as it should; and on the other side the edge of the cone falls *inside* of the line of the shank. These malformations were evidently due to lack of even ordinary care in setting the die that shaped the head. The workman certainly knew that the job was a poor one in this respect. He manifestly belonged to the class of men who do not care whether the work they turn out is good or bad, so long as they "get by" with it.

The fin that projects from the head would make it impossible to calk the rivet at this point, in case of leakage.

The rivet head is too small, showing that the original rivet was too short.

The hole for the rivet was punched, and was neither reamed, drilled out, nor even countersunk to remove the burrs; and so far as can be judged from the specimen itself, the line of travel of the punch made a somewhat oblique angle with the plate, instead of being square with it.

The holes in the two plates were not "fair" with each other.

The rivet was too cold when it was driven, and this fact, combined with the poor driving, prevented it from filling the hole properly. An examination of the rivet itself shows that it touched the sides of the hole only at certain spots, and in some places it evidently stood away from the sheet by quite a distance.

The diameter of the rivet hole at its smallest point was probably intended to be about three-quarters of an inch, although the irregularity of the shank makes this somewhat uncertain, and it may be that the intention was to have the hole seven-eighths of an inch in diameter.

Examination of the rivet suggests that the material itself was none too good, for the tail looks to be hard and brittle —possibly from being burned.

Taking all things into consideration, this job is about as poor a one as we have seen in many a day, yet it is by no means a unique or isolated case. Bad workmanship, with its attendant dangers (which may imperil life and property for many years), is altogether too common, and we are far from sure that conditions are improving in this respect. In fact, we are decidedly of the opinion that there has never before been a time when inspection by competent, disinterested men was more needed than it is today. Boilers should be inspected in the shop during construction and the inspection should include both material and workmanship; and further inspections should be made at regular intervals, after the boilers have been put in operation.

*Reprinted from *The Travelers Standard.*

Uniform Cost Accounting

THE Fabricated Production Department of the Chamber of Commerce of the United States has just issued a report containing a summary of the general conference on uniform cost accounting methods recently held at Chicago. The conference, probably the first of its kind ever held, had for its purpose the interchange of accounting experiences in the development and advancement of uniform methods.

The report reproduces the leading addresses presented by three trade organization executives representing widely varied industries, namely, malleable castings, tents and awnings, and milk. These industries, according to E. W. McCullough, manager of the Department, have accomplished great success in their cooperative cost work, and the addresses clearly explain the benefits secured by these three industries as the result of intensive work in uniform cost accounting methods.

The important features of the discussion which took place at the conference also are covered in the report. This informal part of the conference was devoted to a general discussion of four typical and highly important phases of uniform cost accounting.

Initial copies of the report may be had without charge upon request to the Fabricated Production Department, Chamber of Commerce of the United States, Mills Building, Washington.

Committee on Bolt, Nut and Rivet Standards Approved

THE American Engineering Standards Committee has just approved the personnel of the committee which is developing standards for bolt, nut and rivet proportions under the sponsorship of the Society of Automotive Engineers and the American Society of Mechanical Engineers.

This working committee, which numbers a total of 43 members, 17 of whom represent producers, 24 consumers and 2 general interests, is divided into eight subcommittees, dealing with the following specific subjects:

- Large and small rivets.
- Wrench head bolts and nuts.
- Slotted head products.
- Track bolts and nuts.
- Carriage bolts.
- Special bolts and nuts for agricultural machinery.
- Body dimensions and material.
- Nomenclature.

It is interesting to note that this project originated in a proposal to standardize the widths across flats on nuts and bolt heads, in order to reduce the number of wrenches required to handle the numerous bolts and nuts on machinery and tools. It has often happened that two bolts of the same size would have different nuts or heads, so as to require different wrenches according to the inclinations of individual manufacturers, at very obvious inconvenience and expense to the user.

The chairman of the sectional committee is Professor A. E. Norton of the Mechanical Engineering Department of Harvard University, and the secretary, W. J. Outcalt, of the Standards Department of the General Motors Corporation, Detroit. There are 20 trade and technical societies and groups included in the organization of the committee, namely, the American Electric Railway Association, American Society of Agricultural Engineers, American Hardware Manufacturers Association, American Supply and Machinery Manufacturers Association, American Railway Association (Engineering Division), Associated Manufacturers of Electrical Supplies, Bridge Builders and Structural Society, Electric Power Club, Master Boiler Makers Association, National Machine Tool Builders' Association, U. S. Navy Department, National Association of Stove Manufacturers, Society of Automotive Engineers, Gas Engine and Farm Power Association, Society of Naval Architects and Marine Engineers, American Boiler Manufacturers Association, Railway Car Manufacturers Association, U. S. War Department, American Society of Mechanical Engineers, American Society for Testing Materials; also some manufacturers of bolts and nuts, rivets, wrenches, and machine screws. There are in addition seven independent experts on the committee.

The scope of the work now includes standardization of dimensions, material and nomenclature of all rivets, bolts, nuts, and screws except wood screws, excluding, however, standardization of thread forms, this latter field being covered by the Sectional Committee on Standardization and Unification of Screw Threads, under the same joint sponsorship, in cooperation with the National Screw Thread Commission. This activity is an excellent illustration of the value of the established machinery for carrying on cooperative standardization work.

The American Engineering Standards Committee, which is a federation of the principal national organizations and government departments engaged in standardization work, provides the forum in which all parties concerned with any standard may participate in its formulation under a procedure which assures the democratic representation of all interests. Over 1,000 individuals are now working on such standardization committees.

The part of the work nearest completion is that of the subcommittee on Carriage Bolts, which has issued a report which, after circulation, was approved by the sectional committee by letter ballot, and is now before the sponsors for approval. The report of the subcommittee on Wrench Head Bolts and Nuts has been formulated, and is being circulated generally by the subcommittee for the criticism of American industry.

The personnel of working committees on American Engineering Standards Committee standardization projects is examined by special committees of the American Engineering Standards Committee appointed for the purpose. Their review is to assure a proper balance between producers and consumers and the adequate representation of all essential interests. The committee to review the personnel for this project was headed by Charles A. Mead, as chairman, who is chief engineer, Division of Bridges and Grade Crossings, of the New Jersey Board of Public Utility Commissioners and who represents the American Society of Civil Engineers on the American Engineering Standards Committee.

Gas Manufacturers to Cooperate With Welding Schools

THE Gas Products Association, headquarters at 140 S. Dearborn street, Chicago, Illinois, recently appointed an educational committee to cooperate with trade and technical schools all over the country in supplying a practical and standard course in welding procedure. The users of oxy-acetylene welding equipment have never been thoroughly satisfied with the work done by welding school graduates, and at the same time the application of the welding processes has been extended to so many new fields that the demand for skilled operators is constantly increasing. It is thought that by making a thorough investigation of the needs of the industry and then making recommendations to welding school instructors, the instruction programs can be revised and standardized so as to more fully meet the requirements of the employers. The plan has been already submitted to some schools and has met with their enthusiastic response, so it is felt that the instructors are honestly desirous of giving the students such training as will guarantee them the very best earning power.

The committee will endeavor to build up a list of accredited schools which are known to give a standard instruction, and whose students can be depended upon to qualify as satisfactory welding operators. It is proposed to make this educational movement effective all over the country, and since the members of the Association have gas and apparatus manufacturing plants in practically all of the important industrial centers of the United States, it is quite likely that this plan can be carried through without difficulty.

The Boiler Maker

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CONTENTS

Certain proponents of the arc welding fraternity have apparently acquired the gift of prophecy to a remarkable degree, if certain of the statements appearing in the report on page 307 of the November issue of THE BOILER MAKER, foretelling the relative futures of the arc welding and the oxy-acetylene welding processes are to be taken seriously. Unless these men have been able to look into the future—and some distance at that—and have had a vision of developments in arc welding equipment which so far they *alone* have been able to foresee, it is difficult to understand how they can consider themselves qualified to relegate the gas process to the discard, as they so arbitrarily did.

What advances in the art of electric arc welding they may have had in mind to replace the gas process were not brought out in the report and, as yet, equipment does not exist that by any stretch of the imagination can supplant the torch in many applications where it alone is usable—where portability in the field is essential, where electric current is not available, where economy and rapidity in cutting operations must be realized.

Developments in arc welding will be made and new applications are bound to be discovered—yet the gas people are still alive and their progress will inevitably keep pace with the requirements of the field. The fact that they are very much alive to their opportunities is evidenced by the discovery of a new use for the cutting torch by one of the great railroad systems of the country which will save the road thousands of dollars annually.

Every welder who is unbiased in his opinion and interested solely in the development of the welding art realizes that each process has its legitimate field and can best be used as a complement to the other.

Since the American Boiler Manufacturers' Association and the Stoker Manufacturers' Association have been working in conjunction with each other, many of the difficulties of boiler construction and erection of stoker fired boilers have been eliminated and others are in process of settlement. The activities of the members of the Stoker Association which in a way are closely allied to those of the boiler industry are of considerable interest, and the progress of the former organization may to advantage find reflection in the work of the boiler manufacturers.

The keynote of the recent convention of the Stoker Manufacturers' Association was one of progress—not the least important contribution to which was the report proposing the adoption of a uniform cost accounting system for the industry. This report was prepared by a prominent cost accounting firm well known to the boiler manufacturers after a detailed study of conditions in the field of stoker production. The fact that it was adopted in its entirety is sufficient evidence of its value in the minds of the manufacturers of this type of equipment.

The two fields of stoker manufacture and boiler production are quite comparable in their requirements and careful consideration at the forthcoming winter meeting of the American Boiler Manufacturers' Association to be held at the Hollenden Hotel, Cleveland, February 12, might well be given to the study of a similar uniform cost accounting system for the boiler manufacturing industry. Details of this meeting will appear in the January issue.

The annual index of THE BOILER MAKER for the year 1923 will be published separately from the magazine at the end of the year. As the complete index will be useful only to those of our subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to meet the requirements of those who notify us at once of their desire for a copy.

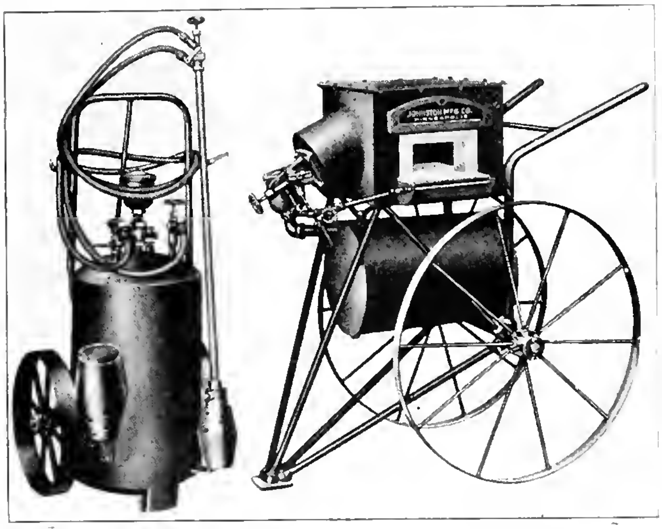
A copy of the annual index will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 1.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Oil-Burning Rivet Forges and Torches

A LINE of modern rivet forges with non-clogging vacuum oil burners, oil-burning torches, and pressure blowers has been developed and recently placed on the market by the Johnston Manufacturing Company, Minneapolis, Minn. The rivet forge, shown in one of the illustrations, is made in three styles, No. 1 for car repair yards, No. 2 for structural steel shops and No. 3 for boiler shops.



Oil-Burning Torch and Rivet Forge for Boiler Shops and Car Repairs

The only difference in these forges is in the capacity of the burners, the No. 3 forge having about one-fourth the capacity of the burner on the No. 1. All the burners are adjustable through the usual range of about one to three, but best results are obtained by having the burner on each forge adapted to its specific use.

Aside from strength and easy portability by means of the large-diameter, ball-bearing wheels with wide tires, the principal feature of this rivet forge is the non-clogging vacuum oil burner. In order to avoid the formation of scale on rivets a uniform flame is necessary, obtainable only by maintaining the oil feed in proper proportion to the air. To accomplish this result the Johnston oil burner was developed with an air inlet valve by which the oil feed is regulated indirectly. This air valve does not clog since only air passes through it and as the air passages in the burner are larger and direct, the oil flow tends to remain uniform, and the character of the gases in the heating chamber consequently remains as first adjusted.

To overcome difficulty from variable air pressure in shops, this burner was so designed that the vacuum by which the oil is drawn up varies directly as the air pressure. The relation between the air and oil supply are, therefore, automatically maintained as first adjusted regardless of changes in air pressure. As a result of the non-clogging feature and provision to offset variable air pressure the character of the flame remains constant; scaling and smoking are reduced to a minimum and the forge operates at high combustion efficiency. The burner has a high vacuum and large oil connections, enabling heavy oil to be used.

The frame of this forge is in the form of a triangle, providing maximum strength and rigidity in proportion to weight. This is a valuable feature, in view of the use and abuse to which rivet forges are put in the course of everyday service.

Forge linings often fail by burning through at the top where the flame strikes and by cracking and spalling around the charging opening. In the Johnston forge the linings are not less than 4½ inches thick where the flames strike and with a charging opening 6 inches wide there is little tendency for this opening to become enlarged by cracking. Additional features are the pivoted tongue which acts as a guard for the burner, the filling funnel and strainer, the air curtain pipe to deflect the hot gases upward and the welded oil tank which has a capacity to hold 20 gallons of fuel oil.

Oil Burning Torches

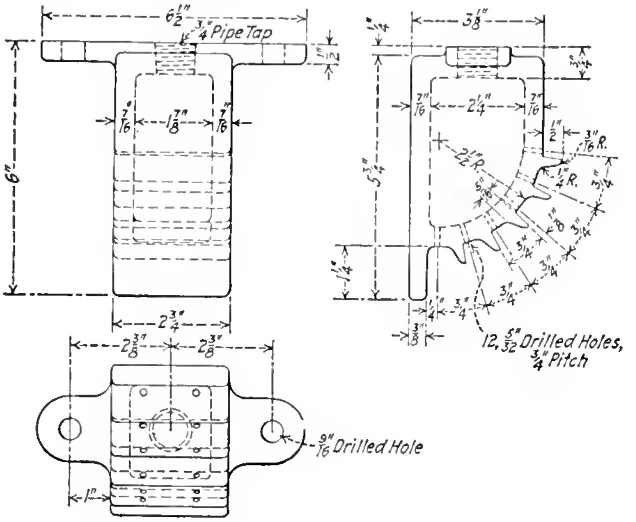
The oil-burning torch illustrated is made in two styles, No. 20 for shop work and No. 21 for firing locomotives for steam test or for starting coal fires in locomotives. The difference between the two styles is in the capacity of the atomizer, the first using 15 gallons of oil an hour and the second 35. This torch, known as the "one man portable," is featured by high capacity and light weight combined with rugged design. This is accomplished by using light, practically unbreakable cast steel nozzles and one large pipe from the torch head to the hose connection. This single pipe is strong and easy to hold. Instantaneous ignition and steady operation are accomplished by a new type atomizer which breaks the oil up into a fine fog close to the torch head and permits the use of a short, and therefore light, single chamber nozzle. Pressure in the oil tank is blown down through the air connection, and this operation does not spray oil over the operator. The filling funnel has a strainer in which the dirt collects and is effectually prevented from entering the tank. Plug cocks are used on air and filling connections for quick and easy operation. The oil hose is protected by an automatic valve which closes in case of failure of the oil hose.

This torch has a wide range of capacity with either nozzle. The large nozzle operates from a small flame 12 inches long up to the big flame required for firing a locomotive boiler for the steam test. Another feature is the tubular handle for the tank, providing a light, convenient grip. The length of hose furnished is 12½ feet. As in the case of the rivet forge the oil tank is welded. It has a capacity of 20 gallons. An extra nozzle for the torch is carried on a bracket as shown in the illustration, being always available. The nozzles are designed to run at moderate temperatures, giving long life.

Frank C. Pickard, master mechanic of the Delaware, Lackawanna & Western at Buffalo, has resigned, effective November 30, to take a position with the Talmage Manufacturing Company at Cleveland.

Ash Pan Sprinkler and Cleaner

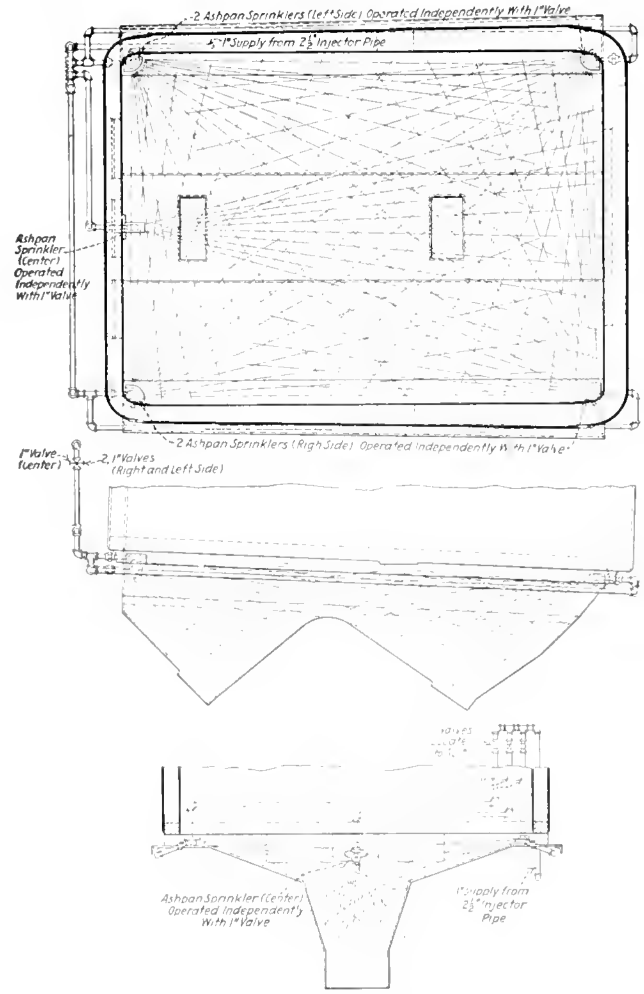
THE Pratte Vacuum Air Sander Company, Denver, Col., has on the market an ash pan sprinkler and cleaner of unique design. Water is piped through a 1-inch pipe from the injector pipe to a number of sprinklers



Drawing of Sprinkler Nozzle for Side of Ashpan

located at strategic points at the center and sides of the ash pan. The water is turned into the supply pipes by a valve in the cab. As shown in the illustration, the sprinkler is designed to spray the water over a large area. The number of sprinklers required depends upon the size of the ash pan. On a pan of 11 feet or more it is recommended that a sprinkler be placed at each corner.

With boiler pressure behind the stream, any fire shaken through the grates can readily be put out and the ash pan given a thorough cleaning. It is claimed that where this device is installed on locomotives, cleaning the ash pans with a hose at terminals is practically eliminated. A better draft through the grates is obtained with a clean ash pan and considerable saving is accomplished as the pan will not warp when this device is used.



Arrangement of Sprinkler on an Ashpan of Large Size

Portable Electrical Recording Instrument

AMONG the recent developments by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., is a new portable recording instrument known as type R. It is made for applications where records as accurate and reliable as those obtained with large switchboard instruments are necessary. Such applications include analysis of motor operation, typical consumption curves of large industrial consumers, and records of power distribution.

The type R instrument is an adaptation of the switchboard recording instrument, with the element as a whole mounted in a portable carrying case. An electric self-winding clock is used for speeds up to 24 inches per hour. For slower speeds, up to four inches per hour, a hand-wound clock can be used.

Alternating current ammeters, alternating and direct current voltmeters, and single and polyphase wattmeters are made in these portable recording instruments.

BUSINESS NOTES

James J. Dale has resigned as vice-president and director of the Consolidated Machine Tool Corporation, New York.

The American Car & Foundry Company has ordered the structural steel for a foundry at Madison, Ill., from the Kenwood Bridge Company.

C. A. Dunn, formerly sales manager of The Weldless Tube Company, has been appointed manager of the Delaware Seamless Tube Company, Auburn, Pa.

D. P. Bennett, vice-president of the Pittsburgh Steel Company, Pittsburgh, Pa., has been elected president, and E. H. Bindley, a director, has been elected vice-president. Henry J. Miller was elected a director to succeed the late Willis T. McCook.

R. P. McCormick will have supervision of the sales activities of the Eastern district for the Pawling & Harnischfeger Company, Milwaukee. He will have offices at 30 Church street, New York, and 605 Stephen Girard building, Philadelphia, Pa.

The Mahr Manufacturing Company, of Minneapolis, Minn., manufacturers of rivet forges, torches, furnaces and kindred oil-burning equipment, has moved its New York office from 50 Murray street to larger quarters at 42 Murray street. Ray G. White is the district representative of the company at New York.

The Linde Air Products Company, New York, recently started continuous operations in its new plant at Tulsa, Okla. Oxygen will be extracted from the air by the liquefaction process. The plant is also able to reclaim the nitrogen and separate the rare gases, argon and neon. C. A. Kennedy is operating superintendent. A Prest-O-Lite plant, for the manufacture of welding and cutting gas, is also planned for the same locality.

Questions and Answers for Boiler Makers

Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.*

Proportions for Cast Steel Rings

Q.—Can you help me in working out the following question? Data: Tank like sketch, Fig. 1, for 300 pounds working pressure. Have no trouble with the thickness of the shell and heads, of course, as the regular rules as given in any of the code books apply all right to these thicknesses. Now how do I arrive at the following dimensions of the cast steel rings by application of rules that I can understand and use for any similar case: Assume roughly a diameter of 70½ inches for "C" if you think it all right.

Required:

1. How thick shall "B" be made, so as to be strong enough; how do you figure it?
2. How do you figure the number of rivets for attaching "B" to end head?
3. How do you figure thickness of bolt flange "A" so as to be strong enough?
4. How do you figure the number and size of the bolts for "A"?

In figuring the number of bolts required, how do you apply the rule for "wrench" pull on bolts, and how do you get so-called "axial" stress in connection with the "wrench pull."

Assume steel castings for rings or flanges, and mild specifications, say 60,000 pounds tensile strength.

As to the number of bolts, do you figure load on same from "test pressure," when you consider the "wrench pull," or do you figure the load from the "working pressure?"

Explain "wrench pull" and "axial stress" so anyone can understand it.

Have use for this information every week or so, and cannot find any satisfactory way of figuring the above out and proving it.

My second question is this: Take a bolt of the shape shown in sketch:

Now how do I figure:

1st. How much will this bolt support in this shape; how is it figured?

2nd. How is the size of the bearing plate and thickness of same figured?

Disregard load on pin, as I am interested in the U-shaped bolt and bearing plate only

This is something like a half of a chain link, but I don't know how to apply a rule to it to figure it out. Several of us have tried our hands at it but cannot get anywhere with it. E. E. B.

A.—The plate thickness required for the shell, Fig. 2, is found from the formula

$$P = \frac{TS \times t \times E}{R \times f} \qquad (1)$$

and

$$t = \frac{P \times R \times f}{TS \times E} \qquad (2)$$

in which P = allowable working pressure, pounds per square inch.

t = thickness of plate, inches.

E = efficiency of riveted joint, in percentage.

TS = tensile strength of plate, pounds per square inch.

R = inside radius of shell, inches.

f = factor of safety.

Example: Given the following values: $P = 300$, $E = 0.90$, $R = 30$, $TS = 55{,}000$ and $f = 5$. Determine the required thickness of shell plate.

Solution: Use the values given in formula (2)

$$\text{Then } t = \frac{300 \times 30 \times 5}{55{,}000 \times 0.90} = 0.[illegible] \text{ inches, say 1 inch for this}$$

problem.

The unit crushing stress in front of the rivets *a* or the shearing stress in the metal *b-b*, Fig. 2, is found from the formula

$$W = S \times A \qquad (1)$$

and

$$A = \frac{W}{S} \qquad (2)$$

in which W = the unit stress in pounds.

S = the allowable stress for shearing, or crushing, pounds per square inch.

A = sectional area required to resist shearing or crushing.

The application of these formulas cannot be made until

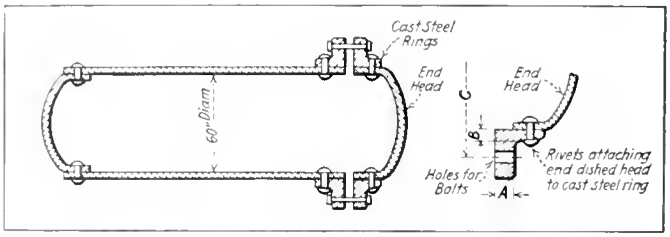


Fig. 1.—Problem to Determine Design of Cast Steel Rings on Tank. Detail of Joint Between Ring and Head Shown at Right

the load on each inch of the circumferential length of the shell is determined.

First find the total load on the head from the formula,

$$W_1 = d^2 \times 0.7854 \times P$$

in which;

W_1 = total pressure on the head end of the cylinder in pounds.

d = inside diameter of shell, inches.

P = working pressure, pounds per square inch.

Example: Substitute the values of the example in the formula given.

Then $W_1 = 60^2 \times 0.7854 \times 300 = 848{,}232$ pounds.

The unit stress in 1 inch of the circumference of the shell equals

$$\frac{848{,}232}{60 \times 3.1415} = 4{,}500 \text{ pounds.}$$

The load tending to shear or crush the ring equals $W = S \times A$, and $A = \frac{W}{S}$. Allowing a safe stress of 5,000 pounds for either of these conditions, the sectional area should equal $A = \frac{4{,}500}{5{,}000} = 0.9$ inch.

Since the load is figured for a circumferential length of 1 inch the thickness of the flange for an area of 0.9 square inch should equal 0.9 inch.

The required number of bolts depends on the diameter of the bolt circle, the safe stress per square inch of bolt section. Assume that 7/8 inch bolts are used. For a good forged bolt 7/8 inch in diameter it will safely carry 4,580 pounds. Owing to the distance required between bolt heads for turning them into place it will be necessary to use two bolt circles, in which case the bolts are staggered. The width of hexagonal nuts across corners equals 1 19/32 inches which would require a pitch of at least 2 1/4 inches between bolt centers.

The internal diameter of the shell equals 60 inches, the shell plate thickness equals 1 inch, the thickness of the flange of the ring where it is riveted to the shell equals 0.9 inch and the center of the first bolt circle is 2 1/4 inches from the inside face of the flange.

The sum of these respective lengths is as follows: $60 + (2 \times 1) + (2 \times 0.9) + (2 \times 2\frac{1}{4}) = 68.3$ inches. The circumference of this circle equals $3.1416 \times 68.3 = 214.57$ inches.

The required number of bolts equals $848{,}232 \div 4{,}580 = 182$.

Using 91 bolts in each circle, the pitch between the centers of the bolts in the inner circle equals $214.57 \div 91 = 2.35$ inches.

The distance between the bolt circles may be made 1 1/4 inches, in which case the bolts in the outer circle stagger those in the inner row and are equally spaced.

The next calculation is to determine the thickness of the flange *d*, which must be sufficient to resist bending and

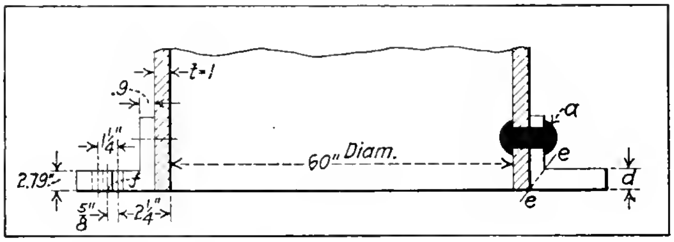


Fig. 2.—Size of Ring Made from Angle Iron

breaking along the plane *e-e*. Consider the section from the inside of the flange to the point *f* midway between the bolt circles as a cantilever beam. The length of the beam equals $2.25 + 0.625 = 2.875$ inches.

The bending moment equals;

$$M = lW$$

in which M = bending moment, inch pounds.
l = length of cantilever.
W = load in pounds.

Substitute in the formula the values $l = 2\frac{7}{8}$ and $W = 4{,}500$

Then $M = 2.875 \times 4{,}500 = 12{,}937.5$.

The section modulus required equals the bending moment divided by the allowable bending stress of the material. Allowing 10,000 pounds as the safe bending stress, the section modulus equals

$$12{,}937.5 \div 10{,}000 = 1.29375, \text{ say } 1.3$$

The section modulus formula for a rectangular section equals

$$Q = \frac{b\,d^2}{6}$$

in which Q = section modulus.
b = shortest side of rectangle, inches.
d = longest side of rectangle, inches.

Therefore,

$$Q = 1.3 = \frac{b\,d^2}{6}$$

and as $b = 1$ inch

$$d = \sqrt{\frac{Q \times 6}{1}} = \sqrt{\frac{1.3 \times 6}{1}} = 2.79 \text{ inches, the}$$

required thickness of the outer leg of the ring at *d*, Fig. 2.

Wrench Sizes

The size of wrench for bolting up as determined by Crane and Company is as follows: Tests show that a compression of 12,000 pounds nearly can be obtained by a man using a 16-inch wrench on 3/4 and 1-inch bolts; a 36-inch wrench on 1 1/8 to 1 3/8-inch bolts; a 60-inch wrench on 1 1/2 to 1 3/4-inch bolts and a 72-inch wrench on 1 7/8 to 2-inch bolts. Square nuts give from 20 to 25 percent less compression than hexagon nuts with a given effort on the wrench.

Lubrication of threads and bearing surfaces increases compression 10 to 15 percent over that obtained with bolt surfaces not lubricated. There is danger of excessive stress being set up in bolts 1 inch in diameter and less. The wrench pull therefore should not exceed that for which it will safely carry; which may be guarded against by using wrenches of the proper length. The following overall lengths of box wrenches are recommended:

Size of bolt, inches	3/4	7/8	1	1 1/4
Size of wrench, inches	11 1/2	13 1/4	15	19

Axial stress is the stress in the plane of and parallel with the axis or center line of the member.

The weakest section of the *U*-bolt is at the bend which is subjected to a bending stress. The bending moment equals

$$M = \frac{W \times l}{20}$$

in which M = bending moment, inch pounds.
W = load on bolt.
l = inside diameter of bend.

Divide the bending moment by the allowable working stress which, for bar sections used, equals 6,000. This gives the section modulus.

The section modulus formula for a round section equals

$$Q = \frac{3.1416 \times d^3}{32} \text{ or } 0.0982 \times d^3.$$

Transposing the formula to find d when Q is known

$$d^3 = \sqrt{\frac{Q}{.0982}}$$

in which d = diameter of the round bar in inches.

Assume that the *U*-bolt is required to support a load of 10,000 pounds and that the inside diameter of the bend equals 2 1/4 inches.

$$\text{Then } M = \frac{10{,}000 \times 2.25}{20} = 1.125 \text{ inch-pounds.}$$

$$1.125 \div 6{,}000 = 0.187, \text{ the section modulus.}$$

$$\text{The value of } d = \sqrt[3]{\frac{.187}{.0982}} = 1\tfrac{1}{4} \text{ inches, nearly.}$$

Boiler Horsepower

Q.—I am taking the liberty to write to you for the following information: Will you kindly give me the formula for calculating boiler horsepower for both tubular and watertube boilers? I want a general formula that is applicable to any boiler of either of the above type regardless of size, providing there is such a formula. If it is not asking too much, could you forward the above to me by mail? Perhaps the answer to my wants would be of some use to a great many other readers of The Boiler Maker, and if space would permit I am sure that the publication of the answer to the above would be appreciated by quite a few.—C. H. P.

A.—The *commercial horsepower* of boilers is dependent on the number of square feet of heating surface and the general design of the boiler. The number of square feet per horsepower has been approximated for different types of boilers. This method is employed by manufacturers in stating closely the boiler horsepower. Some types of boilers are more efficient than others in the evaporation of water.

The definite method of determining the horsepower is by tests. The evaporation of 30 pounds of water per hour from a feedwater temperature of 100 degrees F. into steam at 70 pounds gage pressure, which is equivalent to the evaporation of 34.5 pounds of water from and at 212 degrees F. into steam at the same temperature. The A.S.M.E. give 970.4 British thermal units as required to evaporate 1 pound of water from and at 212 degrees F., hence 970.4 × 34.5 = 33,479 British thermal units per hour transmitted from the fuel to the water. This constitutes the heat value in a boiler horsepower.

The following table gives the approximate number of square feet of heating surface per boiler horsepower for the different types of boilers.

Types of Boiler	Square Feet of Heating Surface Per Boiler Horsepower
Water tube	10 to 12
Tubular	14 to 18
Flue	8 to 12
Locomotive	12 to 16
Vertical tubular	15 to 20

Steaming Capacity of Boilers

Q.—During my negotiations with big boiler manufacturers in this country (England) I was approached by one who is very anxious to obtain certain information which I will briefly explain: They have received inquiries from the states to replace American boilers by their own patent boilers, the American boilers having the following particulars:

(1) Boiler 3 feet 6 inches diameter by 7 feet 0 inches high with 116 vertical 2-inch outside diameter fire tubes.

(2) Boiler 5 feet 2 inches diameter by 9 feet 1 inch high, having 320 1¾-inch outside diameter tubes.

As they are unable to obtain the exact steaming capacity of these boilers so as to offer a similar English boiler, I was wondering whether you could furnish me with these particulars? The firm in question is to bring out several new designs in the near future and I would like to help them if I possibly could.—F. G. B.

A.—The steaming capacity of a boiler is dependent, not only on the amount of heating surface, but also on the size of furnace, combustion space, grate area and their general arrangement.

A boiler may have a large heating surface, yet be a poor steam producer, on account of poor design.

In order to answer your question, further data is required on the size of the furnace or firebox, length of tubes, etc.

Wrapper Sheet Camber Layout

Q.—I am inclosing a sketch of a wrapper sheet camber layout in which the points projected by using the method explained in The Boiler Maker on page 241 do not seem to work out for some reason. I have followed the rules and formula very closely and have checked the work but somehow the stretchout arc did not intersect the points they were intended to. These points are indicated by small circles in the sketch. The reason the curve was drawn with the trammels was to check the work. I note that the dimensions are given in inches but suppose if they were in feet I could use this method of camber layout. Will you please explain regarding this problem. It seems to be a very good method to layout a camber providing the taper for the sheet is known.—M. M.

A.—The solution given in the August issue by R. L. Phelps, for the development of a frustum of a cone is correct. In your sketch you made a mistake in applying the method, which you will understand from the development, Fig. 1, and the following explanation: The elevation of a cone 2 inches in height, having a large base, *M-N*, 3 inches in diameter and a smaller base *O-P*, 2 inches in diameter. Extend the base line *M-N* and make *m-n* equal to

$$\frac{3.1416 \times 3}{2} = 4.71 \text{ inches.}$$

The length *s-p* equals

$$\frac{3.1416 \times 2}{2} = 3.1416 \text{ inches,}$$

which equals the stretchout [illegible] from *p* and at right angles to *s-p*

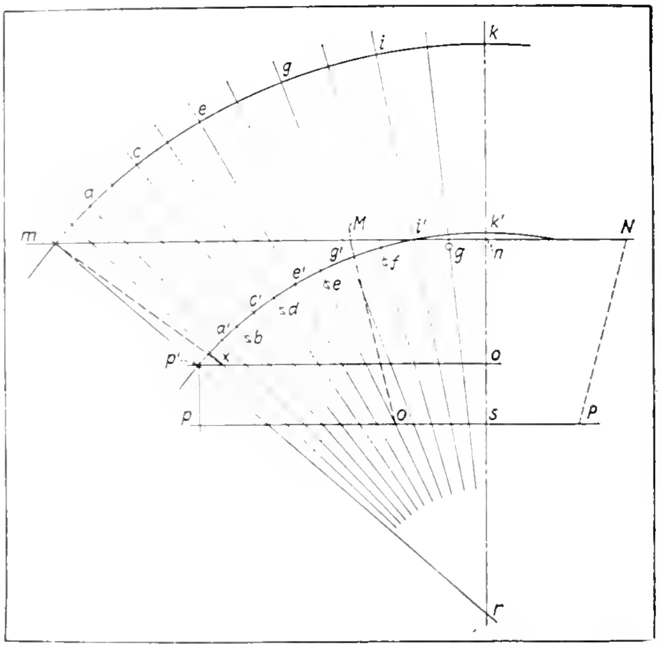


Fig. 1.—Method of Developing a Wrapper Sheet Camber

draw the line *p-p'*. Use the slant height *M-N* of the frustrum and from point *m* draw an arc intersecting line *p-p'* thus locating point at *p'*. Through *p'* draw the line *o-p'* parallel with *m-n*.

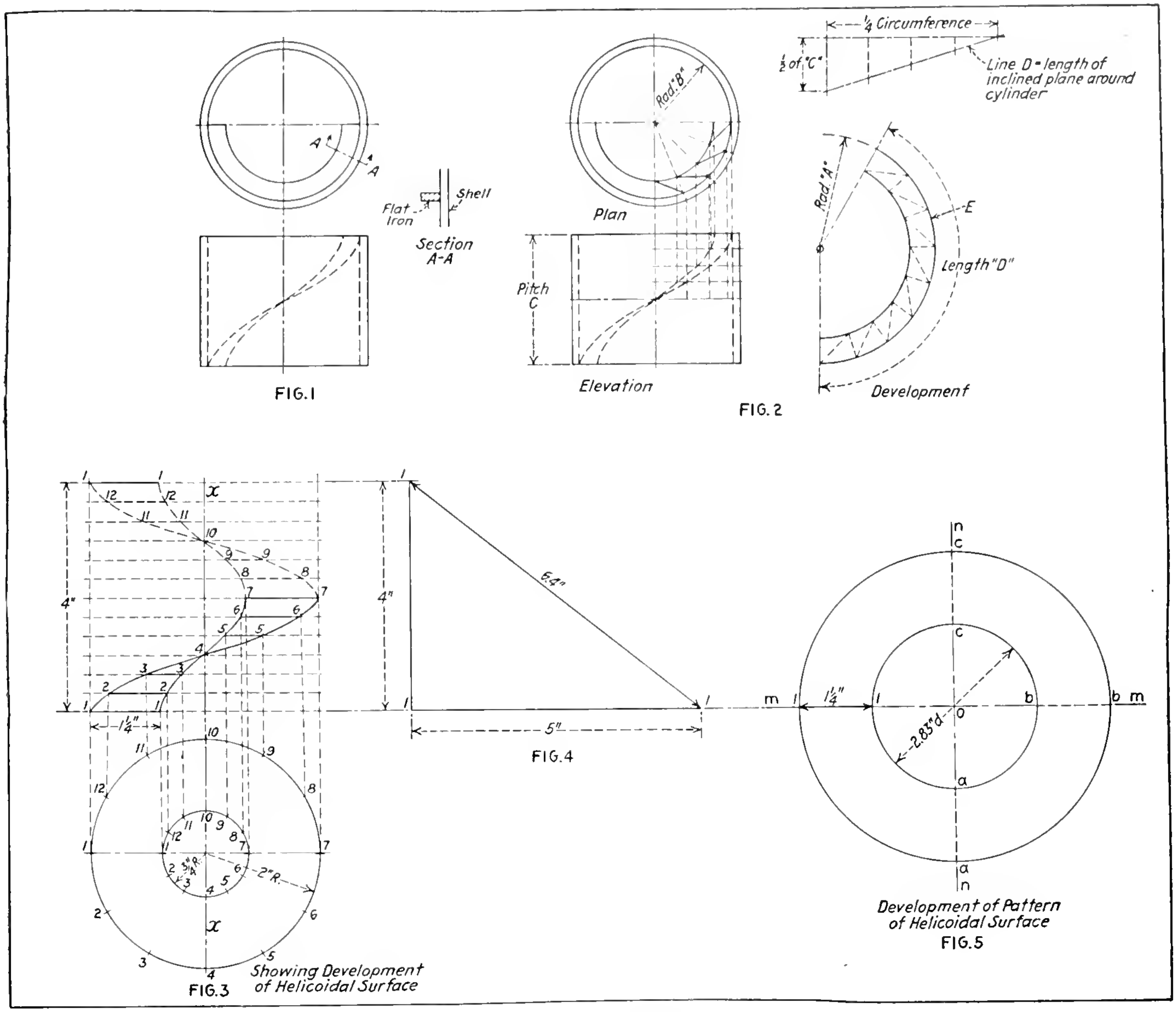
Divide *m-n* and *o-p'* into an equal number of parts, in this case 12. To secure accurate location of the points *a, c, e, g, i* and *k* on the large camber line, a large number of equal divisions should be used. Extend *m-p'* to intersect the center line as at point *r*; also draw in the radial lines through the points located on the stretchout. Use the diagonal length *m-x* and with point *x* as a center locate point *a*. With *a* as a center locate point *b*, then *c, d, e, f*, etc. Using the slant height of the frustrum as *m-p'* and from points *a, c, e, g, i* and *k* locate the points *a', c', e', g', i'* and *k'* which lie on the camber of the small end. By using the radii *r-m* and *r-p'* it will be seen that the curves for the large and small ends pass through the points located.

Calculations and Development of a Helicoidal Surface

Q.—Please give me a solution to the following question if it is possible; those I have asked, say an answer cannot be had, but I believe that to a thorough mathematician a correct answer will be easy: A cylindrical shell is to have a helical flight of flat iron attached to the inside of same as indicated in Fig. 1. Consider the development of the flight as roughly shown in Fig. 2. As you will note, the development as laid out gives a true radius *A* of a circle, which of course is different from radius *B* of the shell. Now, what proportion or relation is radius *A* to radius *B* of the cylinder, and the pitch *C* of the helix? In other words, given the following: Radius *B*, circumference *D* on edge of helix and pitch *C*, then how can I lay out the curve *E* by finding the radius *A*, to bend flat iron flight to, without making a complete development? Radius *A* seems to vary so much from different proportions of *B* and *C*, but I believe that a fixed relation exists that can be put into a simple formula to readily arrive at *A* without all the comparatively unnecessary work of development for a simple flat iron flight that has to be bent edgeways. This problem is a common one for quite a lot of jobs, but I have never seen a solution of it anywhere. The length *D* is, of course, the hypotenuse of a right angle triangle having base equal to the circumference and height equal to the pitch *C*, and is easily arrived at. Can you tell us the proper way of doing this? Such a short cut would save lots of time.—H. M.

A.—The solution of this problem in accordance with the specification stated can be solved for practical purposes as given in Fig. 3, based on the following explanation:

The helix construction is shown in Fig. 1 and the surface between the points *1-1-1* of the inner and outer helices is referred to as a *helicoidal surface*. It will be observed from the construction, Fig. 1, that the surface is developed by a



Layout of Small Helicoidal Surface

straight line *1-1* that is perpendicular to the axis *x-x* of the cylinder as the surface is wound so to speak around the cylinder to make a complete turn in the distance *y*, called the *pitch*.

The helical curves are developed by dividing the circles in the plan which represent the path of helices in that view and by dividing the corresponding pitch *y* into the same number of equal parts. The vertical projections from the points *1* to *12* inclusive are drawn from the plan to intersect the corresponding horizontal projectors in the elevation, thus locating points on the inner and outer helices.

The length of the inner helix is equal to the hypotenuse of the right angled triangle, Fig. 2, of which the base equals the circumference of the inner circle plan view and the height of the triangle is equal to the pitch *y*. The dimensions of a given helicoidal surface are given in Fig 1. Thus the pitch *y* equals 4 inches, outside diameter of helicoid equals 4 inches, and the inside diameter 1½ inches. The base *1-1* of Fig. 2 equals the circumference of the 1½-inch circle plan view, Fig. 1 or $1\frac{1}{2} \times 3.1416 = 5$ inches. The height of the triangle, Fig. 2, equals 4 inches and the hypotenuse equals $\sqrt{5^2 + 4^2} = 6.4$ inches.

From these data the pattern for the complete turn of the helicoid, Fig. 3, may be calculated very closely and developed as shown in the illustration. The circumference of the inner circle, Fig. 3, equals the length of the hypotenuse, Fig. 2 or 6.4 inches. The diameter of a circle having this length equals $\sqrt{\frac{6.4}{.7854}} = 2.83$ inches. Layoff the lines *m-m* and *n-n* at right angles to each other. From point *o* describe a circle with a radius of $\frac{2.83}{2} = 1.415$ inches. From point *1* set off the length *1-1* equal to 1¼ inches and draw the outer circle from point *o* as a center. If the helicoid is of large size the pattern can be split into as many sections as desired. For example, it is divided into four parts as indicated along the lines *1-1*, *a-a*, *b-b* and *c-c*. In such cases allowances are necessary for laps at the joints.

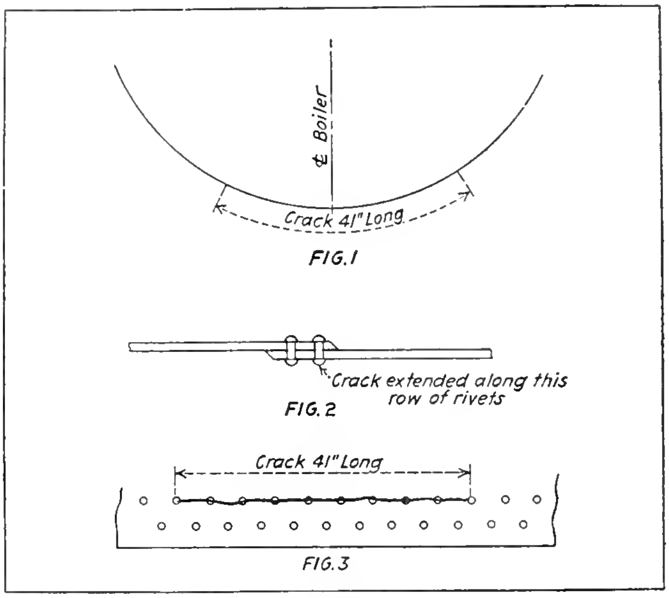
The Interstate Commerce Commission has reopened its investigation into the cost of construction and repair of railway equipment in so far as it pertains to locomotives on the Erie. This is the proceeding in which the commission criticised certain railroads for the amount of the expenditures for repairs to locomotives in outside shops during 1920.

Letters from Practical Boiler Makers

This Department Is Open to All Readers of the Magazine —All Letters Published Are Paid for at Regular Rates

Unusual Barrel Sheet Failure

RECENTLY while inspecting Okmulgee Northern engine No. 2 preparatory to general repairs, a somewhat unusual defect was discovered by boiler inspector J. H. Dozier of the K.O. and G.R.R., at Muskogee, Okla., where the engine is now in the back shop. Noting evidence of leaks in the middle girth seam, the jacket was removed and a crack was discovered zig-zagging from side to side of the rivet



Details of Crack in Barrel Sheet

holes in the back seam of the outer lap for about 20 inches each side of the center line of the boiler. It was necessary to apply a patch 10 inches wide by 64 inches long. It is not known how long this condition had existed nor the cause.

The accompanying sketches will indicate the location and character of what to local boiler makers constitutes an unusual defect.

Muskogee, Okla. M. H. LEARNARD.

What is the Inspector's Duty?

ONE could not help but realize on reading the report of the Bureau of Locomotive Inspection, as given in the August issue of THE BOILER MAKER, how very important it is that boiler inspectors should be competent. In view of the boiler failures, as noted in the report, the question is most urgent.

Taking the case of failure of crown sheet, the condition of crown bolts as shown by sketches prove that something was rotten somewhere, either in the inspection or the supervision. Those conditions could not have developed in one day or a dozen. The failure of the back head, as noted in case 2, shows that all the tools are not dead yet, and a foreman that will have a repair of that kind made should be relieved of his job and given his proper tools,—a wheel-barrow, shovel and a broom.

The two arch tube failures as given in case 3-4, what a sad commentary on the efficiency of inspectors or supervisors. Where is the blame to be laid? Does the inspector see these defects and is he afraid to report them for fear of being bawled out by the foreman for wanting to tie the engines up? Such incidents are common in the daily routine of a boiler inspector, but should not be. Too often the boiler inspector is given to understand that it is not for the amount of work that he can find, that he is there, but rather for how little he reports.

INSPECTOR'S POSITION IN CASE

In discussing these boiler failures with men in the shop, the inspector's side of the case was thus spoken of: What is he to do if he has a foreman that can only see one thing, and that is, get the engines out, and the foreman is, as it were, the final court of appeal? Then I say, take the boiler inspector from under the jurisdiction of any one less than the superintendent of motive power.

Railroad officials cannot recognize any too soon that a competent and unhampered boiler inspector is one of the best paying propositions they can have. In reporting and having small defects repaired before they grow into bigger ones they save the companies thousands of dollars, and, undoubtedly, proper inspection will in the long run save them, not only from heavy financial loss, but also from a lot of unenviable notoriety. A good inspector can have only one viewpoint,—safety first as applied to the boilers that come under his care.

I can think of nothing the editors of THE BOILER MAKER can do that will be of more benefit to everybody concerned than insisting and suggesting a genuine clean-up along the lines of boiler inspection.

Lorain, Ohio. JOSEPH SMITH.

A Scotch Boiler Without Stays

THE cleaning of the outside of the combustion chamber in Scotch marine boilers is made nearly impossible by the great number of screw stays and, as the most efficient heating surface is formed by the combustion chamber plates, the steam production quality of a boiler will be much better if cleaning at regular times is possible, especially when no surface condensing apparatus is installed.

For this reason a boiler design has been worked out and patented in many countries by a Dutch firm. It is shown in the accompanying illustrations which are self-explanatory.

The end plates are arched in order to avoid the troublesome steam space stays.

The advantages claimed for the new design are:

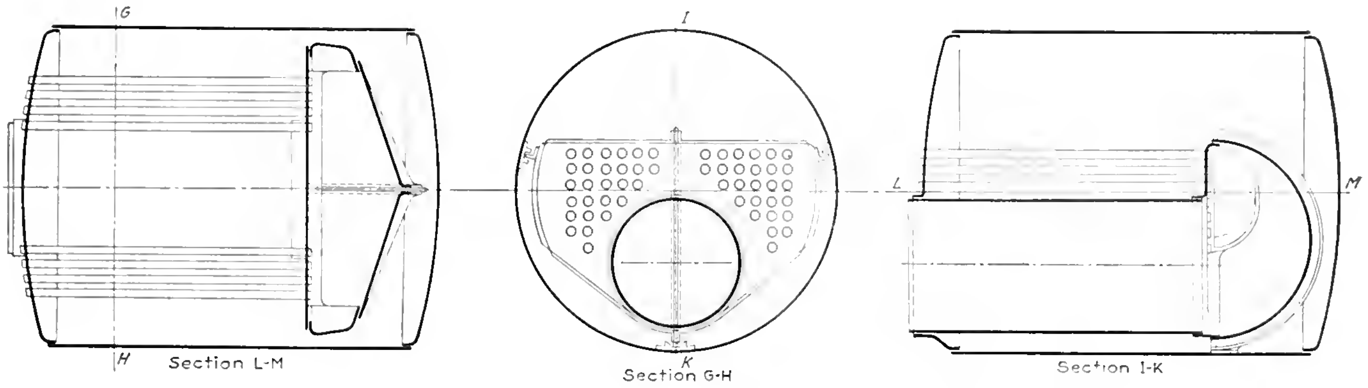
The boiler is easily made at lower cost.

Ample space for the gases for more complete combustion and for entering into the tubes is provided.

Easy cleaning is a special feature.

Better water circulation is realized.

No resistance is offered to the expansion of the furnaces



Sections of Scotch Boiler Showing Method of Bracing to Eliminate Stays

and the tubes in this special type of construction. Repairs can be made at small cost.

The design has also been applied to boilers with two furnaces.

Dordrecht, Holland. BOILER REPAIRER.

Experts Needed for Safe Boiler Inspections

THE explosion as set forth on page 267 of the September issue of THE BOILER MAKER was very disastrous and for a point of argument I would like to have our readers inform me how can grooving along the shell or barrel of this type of boiler be detected. Of course many will readily come forth with the suggestion that it could be found with a hammer but I disagree there for it cannot always be so found. Neither could it be found by visual inspection for it was not visible to the eye at the time of the hydrostatic test nor could it be seen through the washout plug in the front head, for the defect was apparently 3 or 4 feet from the front head.

As long as we allow lap seam boilers to be operated, we are going to have explosions from the source that caused this one and I earnestly believe that inasmuch as we only allow 100 pounds on lap seams of new construction we should also cut down to 100 pounds all lap seams of old boilers that are in existing installations.

DRAWBACKS OF HYDROSTATIC TESTS

This also goes to show that the hydrostatic pressure is not to be depended upon for I have noted several cases where it has failed to 'isclose serious defects.

Not only did the grooving cause the trouble, but the boiler was being operated at an excess pressure. What did the mechanic know about boilers to assert that 135 pounds be allowed? Using a 5/16-inch plate and staybolts spaced 5 inches by 5 inches under new construction, the boiler would only be allowed 110 pounds working pressure. This boiler, having plates ¼ of an inch thick, would certainly not be allowed 100 pounds.

The efficiency of the longitudinal joint was 69.6 percent, therefore

$$\frac{25 \times 60,000 \times 0.696}{17} = \frac{1,044}{17} \text{ or 614 pounds bursting}$$

pressure.

$$\frac{614}{135} = 4.65 \text{ factor of safety.}$$

They were no doubt operating under the factor of safety of 4.65. The writer does give us the age of the boiler but it is by no means of modern design or workmanship and I am at a loss to understand where he obtains 60,000 pounds tensile strength for certainly it could not be found stamped on the sheets after a boiler had gone through the weather and handling that this type of boiler gets.

Where was the inspector, who would allow 150 pounds pressure on a boiler when by using the factor of safety of five he would only allow 122.8 pounds per square inch? This explosion ought to be a lesson to others using lap joint construction that they should when undergoing extensive repairs and hydrostatic or hammer test call in the services of one trained in that line and not any old handy man who thinks he knows all about the boiler simply because he has been around them a year or two. If you hire the services of a doctor you don't call in a quack and if you want a lawyer you don't send for a shyster. Therefore, why call in a shoemaker to work on such a dangerous article as a steam boiler when the skill of an expert is required?

Port Dickinson, N. Y. INSPECTOR.

Government Inspector's Report

(Continued from page 339)

Southampton street, Boston, May 19, 1923, showing condition of firebox sheets and flues "Good—Good," and approved by the officer in charge.

Monthly locomotive inspection and repair report made at Southampton street, Boston, under date of June 7, 1923, signed and sworn to by the inspector, and approved by the officer in charge; monthly locomotive inspection and repair reports made at Southampton street, Boston, under date of July 7 and August 7, 1923, signed and sworn to by the inspector, and approved by the officer in charge, all of which show the condition of flues and firebox sheets "Good—Good."

CONCLUSIONS DRAWN FROM FAILURE

It certainly could not be said that a firebox patched to the extent, as the records show in May, 1922, and to the extent that was found at the investigation of this accident, could be termed in good condition, nor is it at all likely that all firebox leaks which were reported during the month of August developed after the report of August 7 was made.

While it is evident that this accident was primarily due to the failure of the crown sheet because of having been overheated due to low water, it is apparent that the violence of the explosion was increased by the failure of the welded seams, contributed to by two adjacent broken crown stays, and our investigation further made it apparent that the sworn reports covering the condition of this firebox prior to the accident do not represent the true condition.

NEW BOOKS

LOCOMOTIVE CATECHISM. *By Robert Grimshaw. 958 pages, 5½ inches by 7¾ inches. 468 illustrations, bound in cloth. New York: 1923. Norman W. Henly Publishing Company.*

This is the thirtieth edition of a book which for a number of years has been considered the standard authority in its class. It is written in a simple and easily understandable manner such as will appeal to firemen, engineers, trainmen, switchmen, shop hands and enginehouse men for whom it has been prepared. The text follows the form of examination questions and answers, of which there are some four thousand. Considerable new matter has been added in this addition and the old matter carefully revised. The chapters, of which there are 89, are short and conveniently headed for ready reference and cover the various details, such as boilers, cylinders, valve gear, running gear, superheaters, air brakes, etc. The book tells not only what to do, but also what not to do and is specially helpful for a person preparing for an examination for promotion.

WELDING CYCLOPEDIA. *Edited by L. B. McKenzie and H. S. Card, 438 pages, illustrated, 6 inches by 9 inches. Bound in flexible imitation leather. Chicago: 1923. The Welding Engineer Publishing Co.*

This is the third and enlarged edition of a reference book on the theory, practice and application of autogenous welding processes. The first half of the book consists of a dictionary of the terms used in the industry, together with instructions for welding operations of the usual type. Succeeding chapters treat of electric arc welding, electric resistance welding, oxy-acetylene welding and thermit welding in detail. A further section covers the rules and regulations of federal and state authorities and insurance companies. Various charts and tables are included, and at the end of the book is a comprehensive catalogue of welding apparatus and equipment. In this edition information has been added on the training of operators and considerable new material relative to special welding jobs—including tanks, pipes and plate work—has been included.

KENT'S MECHANICAL ENGINEERS' HANDBOOK. *Robert P. Kent, editor-in-chief. Tenth edition; 2,247 pages, 4¼ inches by 7 inches, illustrated. Bound in morocco. New York: 1923 John Wiley & Sons, Inc.*

Kent's handbook needs no introduction to the mechanical engineering public. Since the first edition was published in 1895 and throughout the succeeding eight editions, it has been widely used as a practical reference book of engineering data. These editions, however, have largely been revisions of the material in the first edition, with the addition of new material from time to time as the scope of the mechanical engineering field changed and broadened, and the result has been the gradual development of a lack of balance in the material in the book. Some divisions of the science, which 28 years ago held first rank, are now of relatively minor importance, while other divisions have taken their place. To correct this condition, in the present edition the book has been completely rewritten by a large corps of contributors, each chosen for his fitness to select the material for one of the sections. The editor-in-chief, who is the son of the original founder, has followed the latter's fundamental idea that the book be kept one of engineering practice rather than engineering theory. Among the new subjects appearing for the first time in this edition are [illegible]autics, Automobiles, [illegible] Reinforced [illegible] Safety Engineering [illegible] Design. Many [illegible] have been re- [illegible] practically [illegible] The tenth edition contains over 50 percent more matter than the previous edition, and has been carefully edited to insure the greatest practical convenience to the user.

BOILER MAKER'S POCKET BOOK. *By Maurice John Sexton. Revised by P. W. Maguire. Seventh edition. Pages, 292. Size 3 by 4¾ inches. Illustrated. Bound in cloth. London, England: 1923. E. and F. N. Spon, Ltd. New York: Spon and Chamberlain.*

The seventh edition of this pocket book contains useful information on boiler making, shipbuilding and the steel and iron trades in general. In preparing the seventh edition it has been the endeavor of the authors to supply such information as has been found necessary to bring the material in line with developments during the last few years. The tables in the front part of the book were compiled by the author for his own personal use and should be found valuable in general shop work. Special attention has been paid to the water-tube boiler, general information and descriptions of various types having been included. Superheaters, fuel economizers, chain grate stokers and assisted draft plants have been dealt with; also abstracts from the latest Board of Trade regulations have been given. The book should prove particularly useful to boiler makers, shop foremen, managers and engineers in charge of boiler plants and those interested in the purchase of boilers for commercial use, keeping in mind, however, that the practice is British rather than American and the information should be utilized accordingly.

TRADE PUBLICATIONS

LIGHTING DATA.—Four bulletins on the use of proper lighting facilities in industry have been compiled by the Department of Publicity, Edison Lamp Works, Harrison, N. J. Two of these on lighting legislation and the lighting of steel mills and foundries will be of special interest to many of our readers.

CHARCOAL IRON BOILER TUBES.—An interesting book prepared by the Parkesburg Iron Company, Parkesburg, Pa., outlining the development of process of manufacturing charcoal iron boiler tubes is now available on request. By means of illustrations and descriptive matter the entire story of tubes from the raw material to the finished product is explained in detail.

AIR HOISTS.—Air hoists, patented and built by the Hanna Engineering Works, Chicago, Ill., are described and illustrated with special emphasis given to special features in catalog No. 14 now being sent out by the company. These hoists are designed to meet every known requirement of industry. They embody the simplest possible mechanism and it is stated are free of unnecessary fittings and features that would add to the difficulty of maintenance. The catalog also contains in tabulated form the capacities, weights, code words and other information on Hanna air hoists.

UNDERFEED STOKERS.—The Westinghouse Electric and Manufacturing Company, Stoker Department, South Philadelphia Works, Philadelphia, Pa., describes in some detail the design of a new model multiple retort underfeed stoker. A prominent feature of the new design is the positive control of the contour of the fuel bed. Another feature is the agitating element mounted across the lower end of the stoker adjacent to the retorts which provides a means for maintaining a minimum loss due to combustible in the refuse. The main structure of the stoker is built with heavy supporting members to assure perfect alinement of the parts as well as easy access to an individual part or any group of parts.

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States and Cities That Have Adopted the A. S. M. E. Boiler Code

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Arkansas	Minnesota	Oklahoma
California	Missouri	Oregon
Delaware	New Jersey	Pennsylvania
Indiana	New York	Rhode Island
Maryland	Ohio	Utah
Michigan		Wisconsin

Cities

Chicago, Ill. (will accept)	Memphis, Tenn. (will accept)	Philadelphia, Pa.
		St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
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California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

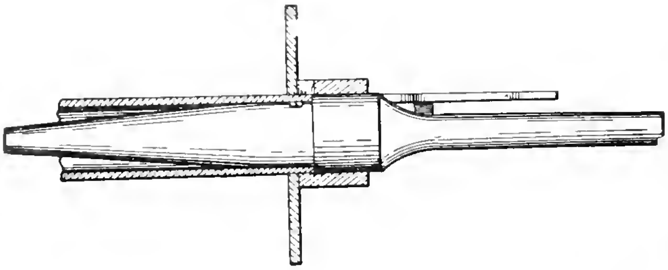
SELECTED BOILER PATENTS

Compiled by
GEORGE A. HUTCHINSON, Patent Attorney,
Washington 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. Hutchinson.

1,440,322. GAGE FOR BOILER TUBES. JOSEPH BENJAMIN WEEKS, OF NORTH SYDNEY, NOVA SCOTIA, CANADA.

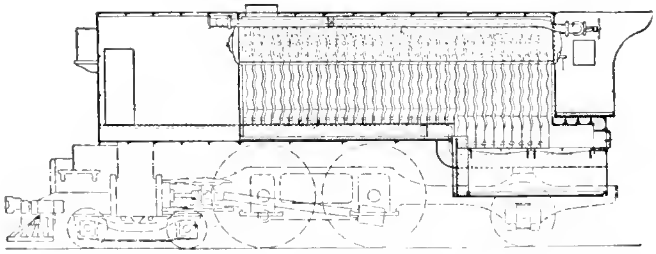
Claim 1.—The herein described apparatus comprising a tapered body portion having a handle formed at one end thereof, a shoulder formed upon



said body portion, a sleeve surrounding said shoulder, a lever pivoted to said body, and a gripping device at one end of said lever for engaging a boiler tube. Five claims.

1,463,494. STEAM CLEANING DEVICE FOR LOCOMOTIVE BOILERS OR THE LIKE. JOHAN BORE AND ALBERT SKOGLUND, OF GOTTENBORG, SWEDEN, ASSIGNORS TO CARL AXEL ARVID WESTERBERG, OF STOCKHOLM, SWEDEN.

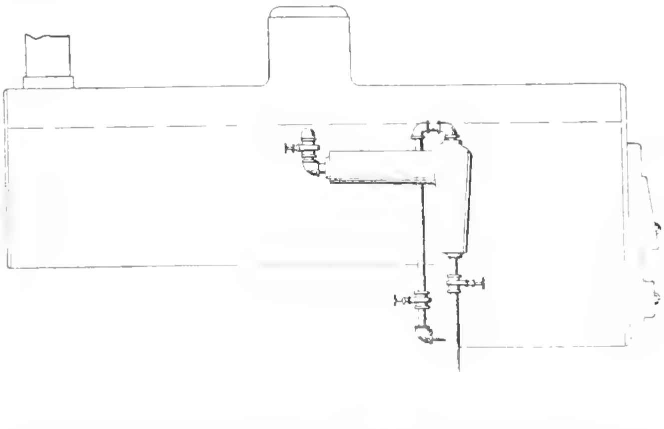
Claim 1.—A locomotive boiler, having a cab at its rear end, a furnace having a side wall, a set of boiler tubes extending lengthwise from the furnace, a tubular nipple extended through the wall with its axis extending



across the axes of the tubes and a steam discharge pipe slidably and rotatably arranged within the nipple, said pipe having a nozzle, and means operable from the cab for turning the nozzle and sliding it transversely of the axis of the tubes for directing the steam into all of said tubes from said nozzle. Eight claims.

1,459,997. BOILER CLEANER. HARGUS G. SHELLY, OF MULVANE, KANSAS.

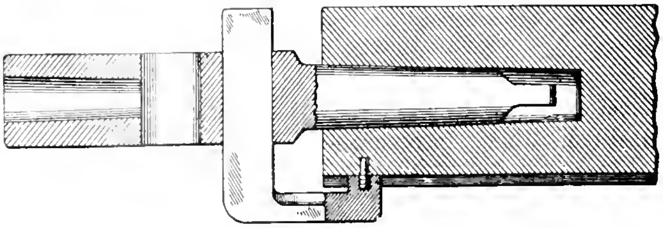
Claim 1.—A boiler cleaner comprising a horizontally disposed elongated vessel having an inlet connection at one end, the other end of said vessel terminating in a dome shaped enlargement, said enlargement having an out-



let connection, a depending sediment well [illegible] forming a continuation of said vessel and said enlargement, said enlargement and said well having downwardly tapering walls, a series of vertical, radially disposed perforated baffle plates in said well and a series of vertical, transversely disposed baffle plates in said horizontally disposed vessel. Two claims.

1,442,234. TOOL HOLDER. FRANK H. PETERSEN, OF DENVER, COLORADO, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO A. L. WESTON, OF DENVER, COLORADO.

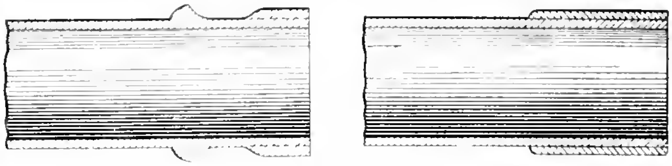
Claim 1.—In apparatus of the class described, the combination with a spindle, means for centering a member thereto, a member centered on the



spindle and having a transverse hole in its body in advance of the spindle end, and means for preventing relative rotation between said member and spindle, said means comprising a dog having a body fitting in said transverse hole. Eight claims.

1,442,458. SUPERHEATER PIPE CONNECTION AND METHOD OF MAKING THE SAME. DAVID H. WILSON, OF WORTENDYKE, NEW JERSEY, AND JAMES E. FULLER, OF FREDONIA, NEW YORK; E. PAULINE WILSON, ADMINISTRATRIX OF SAID DAVID H. WILSON, DECEASED.

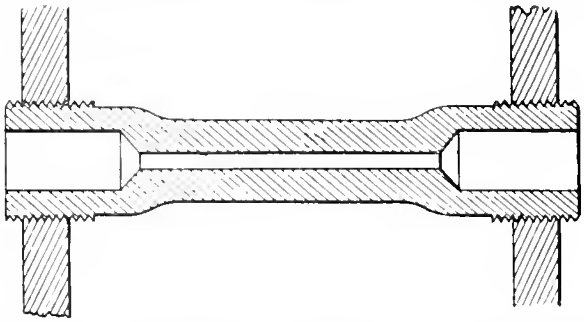
Claim 1.—A superheater tube having a cylindrical inner surface throughout its length, provided upon its outer surface with an upset annular



shoulder, said shoulder being formed upon the outside of said tube from an additional supply of metal stock. Seven claims.

1,466,686. STAY BOLT. WILHELM ZWILLING, OF OSNABRUCK, GERMANY.

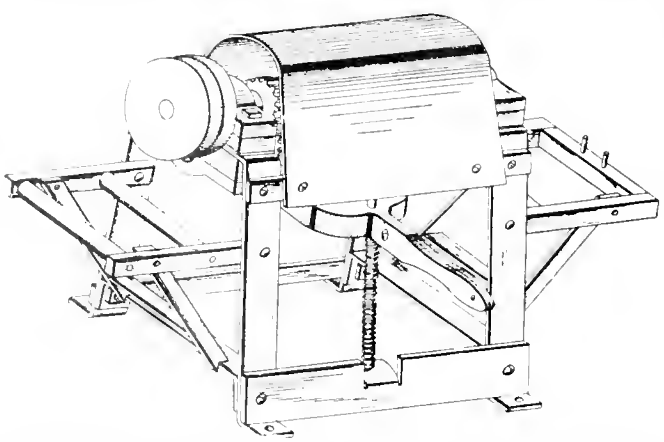
Claim 1.—Staybolt securing means, comprising in combination, a staybolt having an end provided with external screwthreads and with a longitudinally



extending cylindrical cavity; and a die, having a cylindrical active portion of greater diameter than the diameter of said cavity, adapted to be inserted into said cavity, the die being provided with a flange adapted to engage the edge of the wall of the cavity to limit its movements into the cavity. Four claims.

1,466,317. BOILER-FLUE CLEANER OR SCALER. CARL A. VONDERHEID AND HERBERT L. EDDY, OF OIL HILL, KANSAS.

Claim 1.—A boiler flue cleaner comprising a main frame, a rotary cleaner roll provided with a threaded surface, said cleaner roll supported by said frame, bearing rolls for holding a flue in contact with the cleaner roll, rest



frames disposed at opposite ends of the main frame and adapted to support the extremities of a flue interposed between the cleaner and bearing rolls, and said rest frame being mounted to fold within said main frame when the machine is not in use. Three claims.

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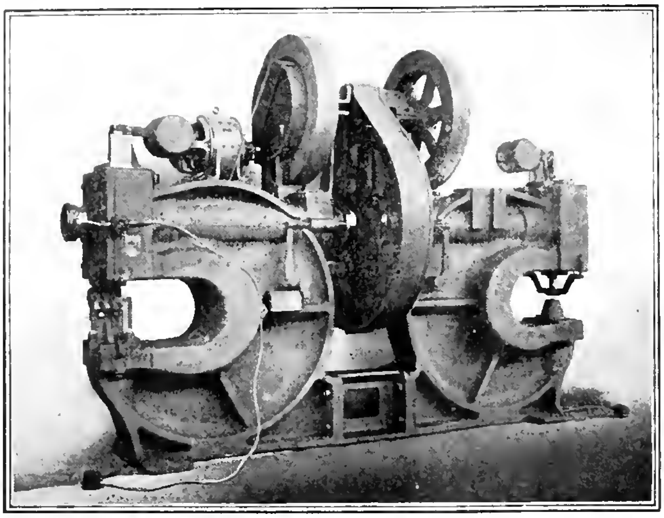

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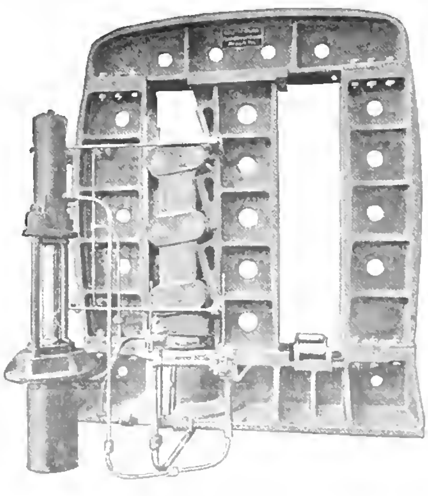

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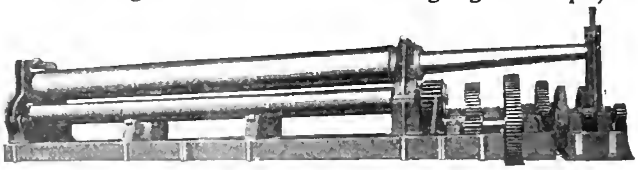

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(See Clamps, Boiler)

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(See Flue Cleaners, Boiler)

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(See Flue Cutters, Boiler)

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(See Boiler Tubes)
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Cleveland Punch & Shear Works Co.
Cleveland Steel Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Scully Steel & Iron Co.

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(See Locomotive Boiler Circulator)

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Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Compressors, Air
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Cocks
Ryerson, Jos. T., & Son

Compressed Air Valves
(See Valves)

Conveying Machinery
Cleveland Punch & Shear Wks. Co.

Coping Machines
Chambersburg Engineering Co.
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son

Copper, Sheet and Bar
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Cost Systems
Ernst & Ernst

Couplings, Hose
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Scully Steel & Iron Co.

Couplings, Pipe
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Cranes
Chicago Pneumatic Tool Co.
Cleveland Punch & Shear Wks. Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Cranes, Hydraulic
Chambersburg Engineering Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Cups, Grease
(See Lubricators)

Cutters
(See Flue Cutters)

Cutting Apparatus (Oxy-Acetylene, Oxy-Hydrogen)
Oxweld Acetylene Co.

Cutting Machines, Irregular
Ryerson, Jos. T., & Son

Cutting-Off Machines, Cold Saw
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son
Scully Steel & Wire Co.

Cylinders, Acetylene
Air Reduction Sales Co.
Oxweld Acetylene Co.

Cylinders, Welded
Continental Iron Works, The
National Tube Co.

Decarbonizing Apparatus
Oxweld Acetylene Co.

Dies
Cleveland Punch & Shear Wks. Co.
Cleveland Steel Tool Co.
Greenfield Tap & Die Corp.

Drills, Air
(See Pneumatic Drills)

Drills, Corner
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.

Drills and Drilling Machines
(Also see Electric Drills)
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Cleveland Punch & Shear Wks. Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Drills and Grinders, Electric
(Portable and Bench)
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Scully Steel & Iron Co.

Drills, Pneumatic
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

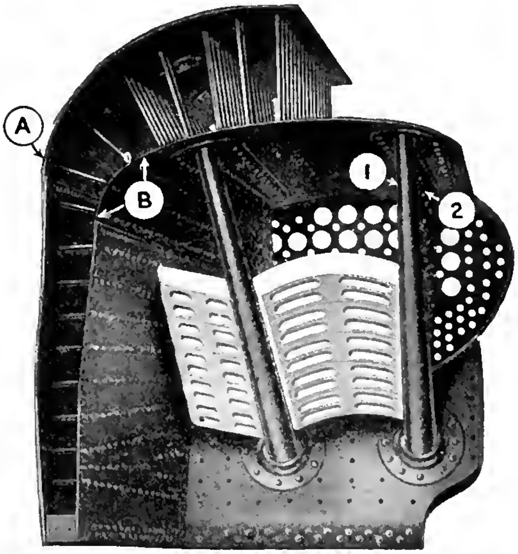
Drills, Radial
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son

Drills, Spindle
Cleveland Punch & Shear Wks. Co.

Drill Sockets
Cleveland Punch & Shear Wks. Co.
Scully Steel & Iron Co.

Drills, Twist
(Also see Drills)
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

How Syphons Affect the Boilermaker



A The wrapper sheet is comparatively cool.

B The firebox sheets are much hotter. This difference in temperature strains and breaks the staybolts.

1 This side of the Syphon is exposed to the full action of hot gases and flame.

2 But this other side of the Syphon sheet is also exposed to the flame. Both sheets being at the same temperature, the bolts which stay them are not over-strained.

FROM the standpoint of maintenance, Nicholson Thermic Syphons can be regarded as simply additional firebox area.

In fact, the maintenance on the Syphons will be even less, since both sheets forming the Syphon are exposed to the same temperatures.

Therefore, the staybolts between them are under no twisting strain. They do not leak or break.

Nicholson Thermic Syphons will never be a burden to the Boilermaker.

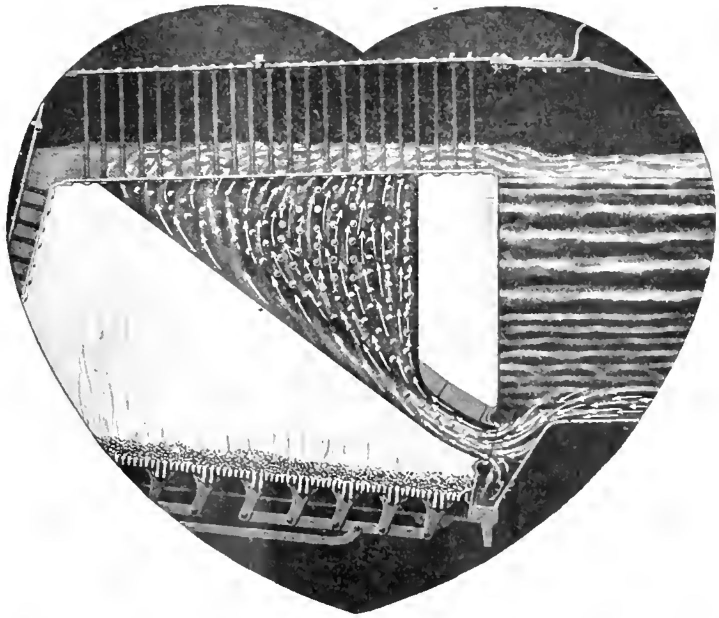
LOCOMOTIVE FIREBOX COMPANY

140 *South Dearborn St., Chicago, Illinois*

The Holden Company, Limited

Montreal *Toronto* *Winnipeg* *Vancouver*

Bulletin No. 5 explains how Nicholson Thermic Syphons increase capacity without adding to the maintenance burden.



NICHOLSON THERMIC SYPHONS

—the Heart of the Locomotive

Electric Welding
(See Arc Welding)

Electrical Apparatus
Burke Electric Co.

Electrical Apparatus and Supplies
General Electric Co.

Ends, Safe
Detroit Seamless Steel Tubes Co.
Globe Steel Tubes Co.
National Tube Co.
Parkesburg Iron Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Engine Bolt Iron
Penn Iron and Steel.

Engines, Oil
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Engineers, Combustion
American Arch Co.

Engineers, Consulting and Efficiency
Ernst & Ernst

Expanders
(Boiler Tube Sectional Beading, Self-Feed for Power)
Chicago Pneumatic Tool Co.
Faessler Mfg. Co., J.
Lovejoy Tool Works.
Scully Steel & Iron Co.
Watson-Stillman Co., The

Expanders, Boiler Flues
(See Expanders)

Expanders, Sectional Beading
(Also see Expanders)
Faessler Mfg. Co., J.
Lovejoy Tool Works.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Expanders, Section Spring Tube
(Also see Expanders)
Lovejoy Tool Works.
Scully Steel & Iron Co.

Firebox, Steel
Lukens Steel Co.

Fireboxes
(See Locomotive Fireboxes)

Fire Brick
(See Brick, Fire)

Fittings
(See Pipe Fittings)

Fittings, Hydraulic
Scully Steel & Iron Co
Watson-Stillman Co., The

Flanges
(See Forged Steel Boiler Flanges)

Flanging Clamps
(See Clamps, Flanging)

Flanged Flue Holes and Manholes
Lukens Steel Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flanging Machinery
Chambersburg Engineering Co.
Cleveland Punch & Shear Wks. Co.
McCabe Mfg. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flanging Machine, Pneumatic
(Also see Flanging Machinery)
McCabe Mfg. Co.

Flanging Presses
Chambersburg Engineering Co.
Southwark Foundry & Machine Co.

Flexible Staybolts
(See Staybolts, Flexible)

Flue Cleaners
Lagonda Mfg. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flue Cutters, Boiler
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Faessler Mfg. Co.
Ingersoll-Rand Co.
Lovejoy Tool Works.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flue Expanders
(See Expanders)

Flue Expanders, Self-Feeding
Faessler Mfg. Co.
Lovejoy Tool Works.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flue Holders
(See Expanders)

Flue Hole Punches and Dies
Cleveland Punch & Shear Wks. Co.
Scully Steel & Iron Co.

Flue Reclaiming
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Flue Welders
Burke Electric Co.
Marshalltown Mfg. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co
Southwark Foundry & Machine Co.
Thomson Electric Welding Co.

Flue Welding Apparatus
(See Welding and Cutting Apparatus)

Flux (Welding)
Air Reduction Sales Co.
Oxweld Acetylene Co.

Forges
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Forges, Oil Rivet
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Forgings
Cleveland Punch & Shear Wks. Co.
Cleveland Steel Tool Co.
Scully Steel & Iron Co.

Forging Presses
(See Presses)
Southwark Foundry & Machine Co.

Forming and Bending Machines
Chambersburg Engineering Co.

Furnaces
(See Forges and Locomotive Furnaces)
American Arch Co.
Continental Iron Works, The
Scully Steel & Iron Co.

Furnaces, Boiler
(See Furnaces)

Furnaces, Bolt Heating
(See Furnaces)

Furnaces, Corrugated
Continental Iron Works, The
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Furnaces, Locomotive
American Arch Co.

Furnaces, Oil
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Gauges, Pressure
Watson-Stillman Co., The

Gauges, Water
Ryerson, Jos. T., & Son

Gauges, Welding
Oxweld Acetylene Co.

Generators, Electric
Burke Electric Co.

Generators Power and Lighting
Burke Electric Co.
General Electric Co.

Globe Valves
(See Valves, Globe)

Gloves, Asbestos
Oxweld Acetylene Co.

Gloves and Goggles
Air Reduction Sales Co.

Goggles, Welding
Oxweld Acetylene Co.

Grates
(Backing, Dumping and Stationary)
Kelly Foundry & Machine Co.

Grease Cups
(See Lubricators)

Grinders
(Electric, Portable and Bench; also see Pneumatic Grinding Machines)
Chicago Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Scully Steel & Iron Co.

Grinders, Pneumatic
(See Pneumatic Grinding Machines)

Grinders, Pneumatic Emery
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Scully Steel & Iron Co.

Grinding Machines, Pneumatic
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Hammers
(See Pneumatic Hammers)

Hammers, Air
(See Pneumatic Hammers)

Hammers, Board
Chambersburg Engineering Co.

Hammers, Chipping, Calking and Beading
(See Pneumatic Tools)

Hammers, Pneumatic
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Oldham, Geo., & Son Co.
Scully Steel & Iron Co.

Hammers, Sand
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Ingersoll-Rand Co.

Hammers, Steam
Chambersburg Engineering Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Heads—Flanged, Dish and Boiler
Lukens Steel Co.

Hoists
(See Chain Hoists, Air Hoists and Electric Hoists)

Hoists, Air
Chicago Pneumatic Tool Co.
Hanna Engineering Works
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Hoists, Chain
Chicago Pneumatic Tool Co.
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Hoists, Electric
Chicago Pneumatic Tool Co.
Scully Steel & Iron Co.

Holders-On, Pneumatic
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Oldham, Geo., & Son Co.

Hoops, Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Hose Clamps
Hardsocg Wonder Drill Co.

Hose, Pneumatic
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Oldham, Geo., & Son Co.
Scully Steel & Iron Co.

Hose, Plain and Armored Rubber
International Oxygen Co.

Hose, Welding
Air Reduction Sales Co.
Oxweld Acetylene Co.

Hydraulic Jacks
(See Jacks, Hydraulic)

Hydraulic Machinery
Chambersburg Engineering Co.
Southwark Foundry & Machine Co.
Watson-Stillman Co., The

Hydraulic Pumps
(See Pumps, Hydraulic)

Hydrogen
International Oxygen Co.

Hydrogen Generating Apparatus
International Oxygen Co.

Iron, Boiler Brace
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Iron Boiler Tubes
(See Charcoal Iron Boiler Tubes)

Iron, Chain
Falls Hollow Staybolt Co.
Penn Iron and Steel Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Iron Staybolts
(See Staybolt, Iron)

Jacks, Hydraulic
Scully Steel & Iron Co.
Watson-Stillman Co., The

Lamps
(Acetylene Flare; see Acetylene Gas)

Lamps, Incandescent
General Electric Co.

Lead Burning Apparatus
(Oxy-Acetylene, Oxy-City Gas)
Oxweld Acetylene Co.

Locomotive Fireboxes
Locomotive Firebox Co.

Locomotive Staybolts
(See Staybolts)

Lubricators
Flannery Bolt Co.
Hanna Engineering Works

Machines, Cold Saw Cutting-Off
(See Cutting-Off Machines, Cdlo Saw)

Machines, Coping
(See Coping Machines)

Machines, Crimping
(See Crimping Machines)

Machine Tool Work
Hanna Engineering Works

Manholes for Boiler and Tanks, Pressed Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Manholes, Forged Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Manhole Crabs, Pressed Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Manholes and Covers
Lukens Steel Co.

Manifolds, Oxygen
Oxweld Acetylene Co.

Metals Perforated
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Manholes and Covers
(See Flanged Flue Holes and Manholes)
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Motors, Air
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.

Motors, Electric
Burke Electric Co.

Motors, Starters and Controllers
General Electric Co.

Nitrogen
Air Reduction Sales Co.

Nitrogen, Gas
Linde Air Products Co.

Nuts
(See Bolts and Nuts)

Nuts, Coupling
Cleveland Punch & Shear Wks.
Cleveland Steel Tool Co., The
Scully Steel & Iron Co.

Oil Burners
(See Torches, Oil Burning)

Oil Cups
(See Lubricators)

Oil Engines
(See Engines, Oil)

Oil Furnaces
(See Furnaces, Oil)

Oil Rivet Forges
(See Forges, Oil Rivet)

Oil and Grease Cups
(See Lubricators)

Oxy-Acetylene Supplies
Oxweld Acetylene Co.

Oxy-Acetylene Welding and Cutting Apparatus
(See Welding and Cutting Apparatus)

Oxygen
Air Reduction Sales Co.
International Oxygen Co.
Oxweld Acetylene Co.

Oxygen, Gas
Linde Air Products Co.

Patch Bolts
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Patch Bolt Countersink Tools
Faessler Mfg. Co., J.
Lovejoy Tool Works.

Patterns
Cleveland Punch & Shear Wks. Co.

Pins
(Air Brake and Knuckle)
Champion Rivet Co.

Pins, Drift
Cleveland Punch & Shear Wks. Co.
Cleveland Steel Tool Co.
Scully Steel & Iron Co.

Pipe
National Tube Co.

Pipe, Cast Iron
American Car & Foundry Co.

Pipe Bending Machines
Chambersburg Engineering Co.
Chicago Pneumatic Tool Co.
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Watson Stillman Co., The

Pipe Couplings
(See Couplings, Pipe)

Pipe Fittings
Southwark Foundry & Machine Co.

Pipe Flanges, Pressed Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Pipe Plugs
Townsend Company

Pipe and Tubes, Arch
Detroit Seamless Steel Tubes Co.
Globe Steel Tubes Co.
National Tube Co.
Parkesburg Iron Co.

Planers, Plate
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Southwark Foundry & Machine Co.

Planers, Rotary
Cleveland Punch & Shear Wks. Co.
Hanna Engineering Works

Plate Heating Furnaces
(See Furnaces)

Plate Planers
(See Planers, Plate)

Plate Shears
(See Shears, Plate)

Plate Steel
(Also see Boiler Plates)
Lukens Steel Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Plates, Boiler
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Plates, Sheared
(Iron and Steel)
Bethlehem Steel Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Pneumatic Flanging Clamps
(See Flanging Clamps)

Pneumatic Hammers
(See Hammers, Pneumatic)

Pneumatic Holders-On
(See Holders-On, Pneumatic)

Pneumatic Hose
(See Hose)

Pneumatic Hose Couplings
(See Hose Couplings)

Pneumatic Punches
(See Power Punches)

Pneumatic Rivet Forges
(See Forges; also Oil Rivet Forges)

Pneumatic Shears
(See Power Shears)

Pneumatic Staybolt Clippers
(See Staybolt Clippers, Pneumatic)

Pop Safety Valves
(See Valves)

Portable Drills
(See Drills; also Electric Drills)

Power Riveters
(See Riveters, Power)

Preheating Apparatus
Oxweld Acetylene Co.

Pressed Steel Boiler Nozzles
(See Boiler Nozzles, Pressed Steel)

Presses, Arbor
Watson-Stillman Co., The

Presses, Bending
Bertsch & Co.

Presses, Bushing
Watson-Stillman Co., The

Presses, Crank Pin
Watson-Stillman Co., The

Presses, Dishing
Southwark Foundry & Machine Co.

Presses, Flanging
Chambersburg Engineering Co.
Watson-Stillman Co., The

Presses, Forging
Chambersburg Engineering Co.
Watson-Stillman Co., The

Presses, Hydraulic
Chambersburg Engineering
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Watson-Stillman Co., The

Presses, Power
Chambersburg Engineering Co.

Presses, Upsetting, Hydraulic
Watson-Stillman Co., The

Presses, Wheel
Watson-Stillman Co., The

Pumps
(Boiler Test)
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Pumps, Hydraulic
Chambersburg Engineering Co.
Scully Steel & Iron Co.

Pumps, Test
Scully Steel & Iron Co.

Pumps, Vacuum
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.

Punches
Bertsch & Co.

Punches and Dies
Cleveland Punch & Shear Works Co.
Cleveland Steel Tool Co.
Greenfield Tap & Die Corp.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches, Hand
Cleveland Steel Tool Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches, High Speed
(See Power Punches)

Punch Holders
Cleveland Punch & Shear Works Co.
Cleveland Steel Tool Co.
Scully Steel & Iron Co.

Punches, Horizontal
Cleveland Punch & Shear Wks. Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches, Hydraulic
Scully Steel & Iron Co.

Punches, Multiple
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches, Power
Chambersburg Engineering Co.
Cleveland Punch & Shear Works Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches, Screw
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punches and Shears Combined
Chambersburg Engineering Co.

Punches, Shears and Bar Cutters, Combined
Chambersburg Engineering Co.
Cleveland Punch & Shear Wks. Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Punching Machine, Combined Punch, Shear and Cope
Chambersburg Engineering Co.

Reamers
Bruhaker & Bros. Co., W. L.
Chicago Pneumatic Tool Co.
Greenfield Tap & Die Corp.
Hanna Engineering Works
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Recording Gages
(See Gages)

Regulators (Oxygen and Acetylene)
Air Reduction Sales Co.

Regulators, Compressed Air
Oxweld Acetylene Co.

Reseating Machines, Cap and Header
Lagonda Mfg. Co.

Rivets
Burden Iron Co.
Champion Rivet Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Townsend Company

Rivet Busters
Chicago Pneumatic Tool Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Scully Steel & Iron Co.

Rivet Cutting
Air Reduction Sales Co.
Oxweld Acetylene Co.

Rivet Forges
(See Forges; also Portable Rivet Forges)
Independent Pneumatic Tool Co.

Rivet Forges, Portable
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Rivet Heaters, Electric
American Car & Foundry Co.

Rivet Iron
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Rivet Sets
Chicago Pneumatic Tool Co.
Cleveland Steel Tool Co.
Cleveland Pneumatic Tool Co.
Cleveland Punch & Shear Works Co.
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Riveters, Compression
(Also see Power Riveters)
Allen Co., John F.
Chicago Pneumatic Tool Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Riveters, Hydraulic
Chambersburg Engineering Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Southwark Foundry & Machine Co.
Watson-Stillman Co., The

Riveters, Percussion
(Also see Power Riveters)
Allen Co., John F.

Riveters, Pneumatic
(Also see Power Riveters)
Allen Co., John F.
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Hanna Engineering Works
Independent Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Riveters, Power
(Also see Compression Riveters and Pneumatic Riveters)
Allen Co., John F.
Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Hanna Engineering Works
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Riveting Hammers
(See Hammers, Pneumatic)

Rods, Welding
Oxweld Acetylene Co.

Rolls, Angle Bending
Bertsch & Co.

Rolls, Bending and Straightening
Bertsch & Co.

Rollers, Flue and Tube Expanders
(See Expanders)

Safety Valves
(See Valves)

Sand Hammers
(See Hammers, Sand)

Sand Sifters
(See Sifters, Sand)

Saws
(Friction, Hot Metal)

Saws, Metal
Cleveland Punch & Shear Works Co.
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

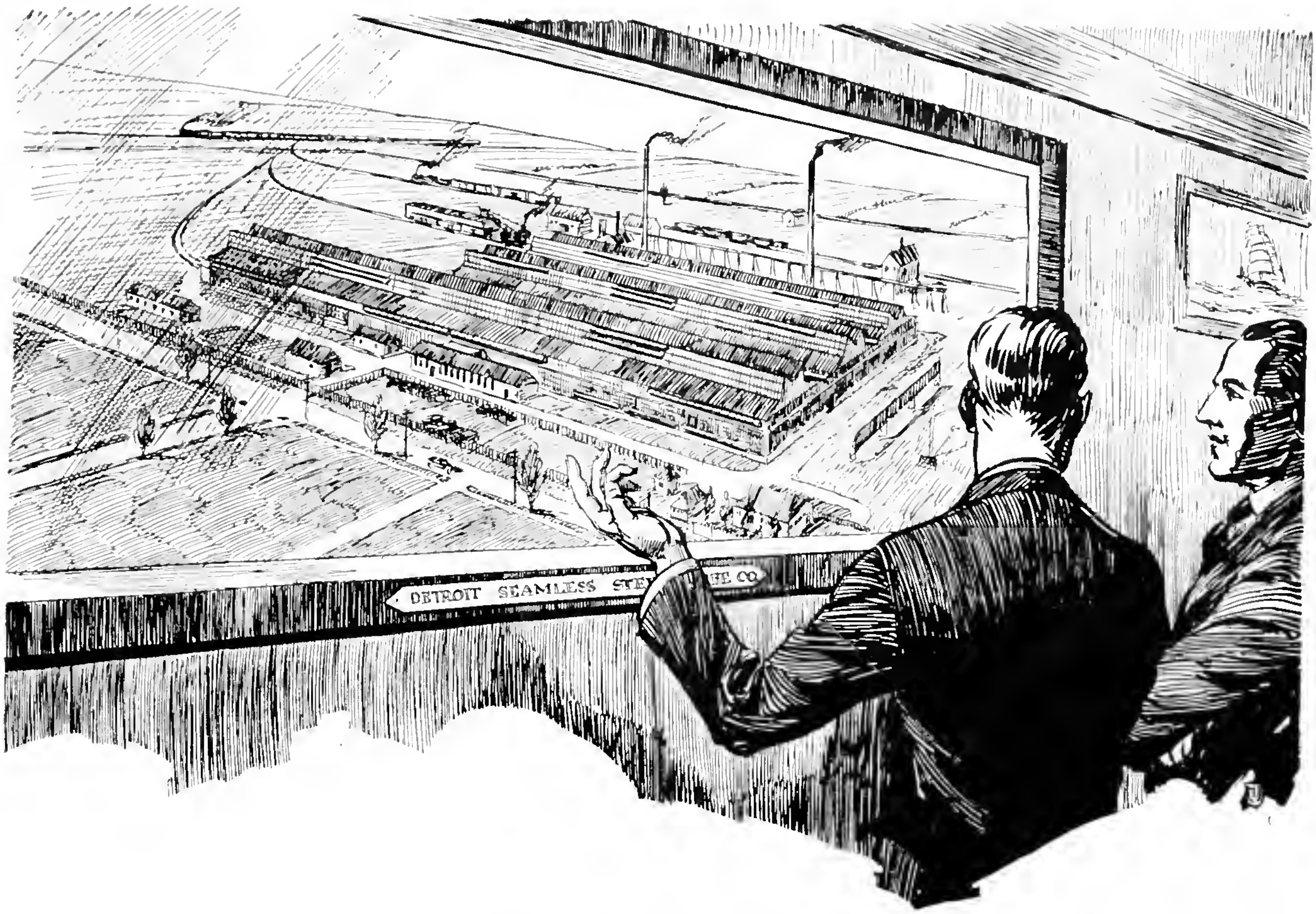
Saws, Power, Hack and Cold Cutting
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Seamless Forged Steel Boiler Nozzles
(See Forged Steel Boiler Nozzles)

Second-Hand Machinery
(See Machinery)

Sectional Flanging Machines
(See Flanging Machinery)

Shafting
(Hollow, Charcoal, Iron or Steel)
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.


DETROIT SEAMLESS

Shear Blades
Cleveland Punch & Shear Wks. Co.
Cleveland Steel Tool Co., The
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shearing Machines, Angle
Chambersburg Engineering Co.
Southwark Foundry & Machine Co.

Shearing Machines, Bevel
Chambersburg Engineering Co.

Shearing Machines, Bar Iron
Chambersburg Engineering Co.
Southwark Foundry & Machine Co.

Shearing Machines, Gate
Southwark Foundry & Machine Co.

Shearing Machines, Plate
Chambersburg Engineering Co.
Southwark Foundry & Machine Co.

Shearing Machines, Rotary
Southwark Foundry & Machine Co.

Shearing Machines, Serpentine
Ryerson, Jos. T., & Son

Shears, Bevel
Cleveland Punch & Shear Works Co.
Marshalltown Mfg. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shears, Gate
Bertsch & Co.
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shears, Gap Splitting
Bertsch & Co.

Shears, Guillotine
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shears, Hand
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shears, Plate
Southwark Foundry & Machine Co.

Shears, Power
Chambersburg Engineering Co.
Cleveland Punch & Shear Works Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Shears, Rotary
Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.
Southwark Foundry & Machine Co.

Shears, Splitting
Marshalltown Mfg. Co.
Southwark Foundry & Machine Co.

Shears, Throatless
Marshalltown Mfg. Co.

Sheet and Bar Copper
(See Copper, Sheet and Bar)

Shears, Sheet Metal
Ryerson, Jos. T., & Son

Shears, Splitting
Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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(See Steel, Sheet)

Sheets, Galvanized Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Ship Rivets
(See Rivets)

Sifters, Sand
Chicago Pneumatic Tool Co.
Hanna Engineering Works

Sockets
(See Drill Sockets)

Staybolt Bars
American Locomotive Co.
Burden Iron Co.
Falls Hollow Staybolt Co.
Rome Iron Mills, Inc.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Chicago Pneumatic Tool Co.
Cleveland Pneumatic Tool Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolt Iron
Globe Steel Tubes Co.
Falls Hollow Staybolt Co.
Penn Iron and Steel Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolt Iron, Hollow
Falls Hollow Staybolt Co.
Rome Iron Mills, Inc.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolt Steel
Burden Iron Co.
Detroit Seamless Steel Tubes Co.
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Independent Pneumatic Tool Co.
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Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolt Rivet Sets
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Cleveland Pneumatic Tool Co.
Cleveland Punch & Shear Works Co.
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Ingersoll-Rand Co.
Ryerson, Jos. T., & Son
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(Also see Taps and Dies)
Brubaker, W. L., & Bros.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolts
American Locomotive Co.
Detroit Seamless Steel Tubes Co.
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel-Iron Co.

Staybolts, Cut
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Staybolts, Drilled
Penn Iron and Steel Co.

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American Locomotive Co.
Flannery Bolt Co.

Staybolts, Threaded
Falls Hollow Staybolt Co.
Ryerson, Jos. T., & Son

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Flannery Bolt Co.

Stays, Crown (Flexible)
Falls Hollow Staybolt Co.
Flannery Bolt Co.

Steam Hose
Ingersoll-Rand Co.

Steel, Sheet
(Also Galvanized Steel Sheets)
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Steel Boiler Tubes and Arch Tubes
(See Boiler Tubes, Steel)

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(See Plate Steel; also Sheet Steel)

Steel Shafting
National Tube Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Globe Steel Tubes Co.
National Tube Co.
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Scully Steel & Iron Co.

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Cleveland Punch & Shear Wks. Co.
Ryerson, Jos. T., & Son
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Watson-Stillman Co., The

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Detroit Seamless Steel Tubes Co.
Globe Steel Tubes Co.
National Tube Co.
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Locomotive Firebox Co.

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(See Rivets)

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(See Acetylene Gas)
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Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Tees, Steel
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Tool, Steel
Cleveland Steel Tube Co.
Ryerson, Jos. T., & Son
Scully Steel-Iron Co.

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Cleveland Pneumatic Tool Co.
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Independent Pneumatic Tool Co.
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McCabe Mfg. Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Oxweld Acetylene Co.

Torches, Cutting
Oxweld Acetylene Co.

Torches, Welding
Oxweld Acetylene Co.

Torches, Welding and Cutting
Oxweld Acetylene Co.

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Cleveland Punch & Shear Wks. Co.

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Hanna Engineering Works
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Oxweld Acetylene Co.

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(See Flue Cutters)

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(See Expanders)

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Lukens Steel Co.

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(See Machines, Tube Welding)

Tubes
(Charcoal Iron; see Charcoal Iron Boiler Tubes)

Tubes, Arch
Detroit Seamless Steel Tubes Co.
National Tube Co.
Ryerson, Jos. T., & Son

Tubes, Boiler
Detroit Seamless Steel Tubes Co.
Globe Steel Tubes Co.
National Tube Co.
Parkesburg Iron Co.
Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

Tubes, Boiler, Steel
Detroit Seamless Steel Tubes Co.
National Tube Co.
Ryerson, Jos. T., & Son

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(Seamless: see Seamless Steel Tubings)

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Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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Scully Steel & Iron Co.

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Ryerson, Jos. T., & Son
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Ryerson, Jos. T., & Son
Scully Steel & Iron Co.

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(See Radial Drills)

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Continental Iron Works
National Tube Co.

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Air Reduction Sales Co.
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Ryerson, Jos. T., & Son
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Air Reduction Sales Co.
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Welding Process
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International Oxygen Co.
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Wire
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Wire Welding
Oxweld Acetylene Co.

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Scully Steel & Iron Co.

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